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PROBLEMS OF ANGIOCARDIOGRAPHY*†

By RUSSELL H. MORGAN, M.D.

BALTIMORE, MARYLAND

I. INTRODUCTION

DURING the past few years, angiocardiography has become a well established procedure for the detection and identification of a number of cardiac anomalies and disorders. The usefulness of the technique in the diagnosis of such conditions as the tetralogy of Fallot, pseudotruncus arteriosus, tricuspid atresia and coarctation of the aorta cannot be questioned. Furthermore, with the introduction of corrective surgical methods for many of these disturbances, the importance of angiocardiography has become even greater, for it may consistently provide much guiding information for the surgeon in his operative planning.

Since angiocardiographic methods were first introduced, a number of techniques have been developed for carrying out this type of roentgenographic examination. Early workers including Robb and Steinberg[3] placed the patient before a conventional vertical cassette changer and then after the intravenous injection of a solution of 70 per cent diodrast, made a pair of films with an interval calculated to expose the patient when the opaque material was at critical points in the circulation. This timing was usually calculated from measurements of the patient's circulation time before the examination was begun. Although in many instances this technique gave the desired diagnostic information it was soon realized that two films were not sufficient where precise evaluation of the patient was required. Accordingly there began an evolutionary period during which a number of multiple-film devices were developed specifically to meet the problems of angiocardiography. Descriptions of many of these instruments have been published. Probably, many more are still unreported.

The first developments were in the direction of apparatus which used conventional roentgenographic cassettes arranged in some sort of a rack which moved the cassettes into place behind the patient at a rate of one cassette every second or two. Some of these devices were hand-operated, some gravity-driven and some motor-activated. Usually they carried six or eight cassettes and as one might expect they were extremely noisy and cumbersome. Much good angiocardiography has been per-

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formed with the several varieties of equipment of this type. However, they still did not provide the speed and flexibility that many workers wished. In an effort to meet these requirements Scott[4] and his coworkers in St. Louis recently adapted an aerial type roll film magazine which permits angiocardiographic procedures to be done at a rate of two exposures per second on roentgenographic roll film, 9 inches in width. Although this apparatus still has a few limitations, it effectively solves the great majority of the problems encountered in the equipment that preceded it. Furthermore, since this magazine is now being made commercially available one may expect to see it used rather extensively in angiocardiographic installations from now on.

II. DANGERS OF ANGIOCARDIOGRAPHY AND THEIR POSSIBLE SOLUTION

Now that the engineering problems in angiocardiography have been largely overcome, many radiologists will likely begin to employ the technique in the solution of their cardiac problems. It has therefore seemed wise to us at this time to point out some of the dangers which are encountered by the patient and radiologist in the performance of this procedure. These dangers include a rather serious radiation hazard to the radiologist if adequate precautions are not observed and a relatively high mortality rate in patients who are subjected to the procedure. Not much attention has been paid to either of these dangers until now, but it is believed that they are sufficiently serious to demand the careful consideration of all those who are embarking on an angiocardiographic program.

Until now it has been standard practice at most institutions where angiocardiography is done for the radiologist to inject the opaque material with little or no protection to himself. In some instances leaded aprons have been worn but the arms and hands have often been exposed dangerously near the direct roentgen-ray beam.

In an effort to evaluate the magnitude of this problem we recently explored the exposure conditions about our angiocardiographic installation at the Johns Hopkins Hospital. The results of this study are shown graphically in Figures 1 and 2 where isodose curves are plotted first in a lateral plane to the side of the roentgenographic table and then in a transverse plane through the roentgenographic table at the level of the roentgen tube.

These data apply to the radiation conditions which exist when a series of eight films is made of a chest, 12 cm. in thickness, in the anteroposterior projection and with exposure factors of 70 kilovolts (peak), 15 milliampere-seconds for each film, and a tube-film distance of 36 inches. The total filtration including the inherent filtration of the roentgen tube was 2.2 mm. of aluminum, and the field size at the film was 150 square inches. No grid was employed. Values considerably greater than those shown in the charts were of course obtained for larger individuals. Indeed an adult chest taken in the lateral projection and measuring 27 cm. produced readings 6.5 times those shown for a series of eight films made at 85 kv. (peak) and 30 ma-sec. per film. For infants, the radiation exposure conditions on the other hand are less serious. One infant, measuring 10 cm. produced readings 0.5 times those shown when a similar series of films was made at 60 kv. (peak) and 15 ma-sec. per film.

It will be observed from the data presented in Figures 1 and 2 that a considerable quantity of radiation can be received during angiocardiography by a radiologist standing close to the patient. This radiation hazard is particularly marked in the region where the radiologist's hands and arms are placed during and after the injection of the patient. Some workers have tried to overcome this problem by draping the patient's arm with protective lead shields of one sort or another. Although some of these methods have been ingeniously carried out, they are often crude and clumsy and frequently their protection is incomplete.

In an effort to solve this problem more

effectively we have designed and constructed the remote-control injection system shown in Figure 3. This device consists of a double clamp mechanism which holds the filled syringe securely over the patient's arm. The syringe is connected to the needle in the patient's antecubital vein by a short, 4 cm., length of flexible rubber tubing which is armored by stainless steel wire to permit the tubing to withstand the high intraluminal pressures that may be encountered.

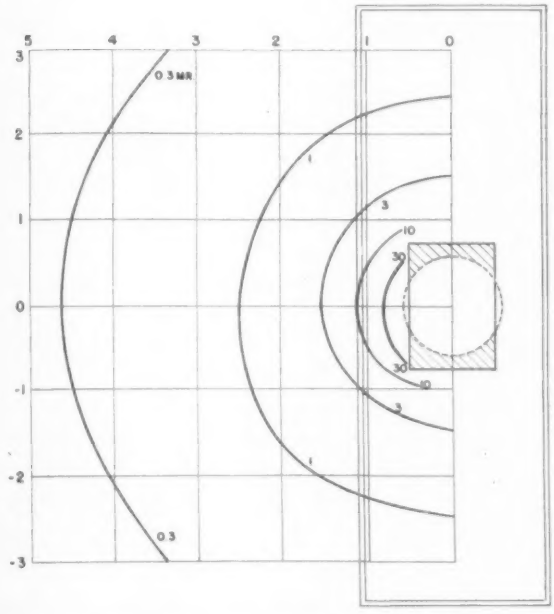

Fig. 1. Isodose curves giving in milliroentgens the radiation conditions which exist during angiocardiography to the side of a typical roentgenographic table. Conditions of exposure: radiation produced by roentgen generator operating at 70 kv. (peak) and 120 ma-sec.; filtration included 2.2 mm. of aluminum; field size measured 150 square inches at the film; tube-film distance was 36 inches; thickness of patient's chest was 12 cm. Ordinates and abscissae are at intervals of 1 foot.

As a part of the clamping mechanism, the device also includes a small vacuum cylinder and piston. A small extension piece attached to the external end of the piston presses firmly against the end of the syringe's plunger. The device is operated by connecting the cylinder of the instrument to a vacuum bottle on which is mounted a hand-operated control valve.

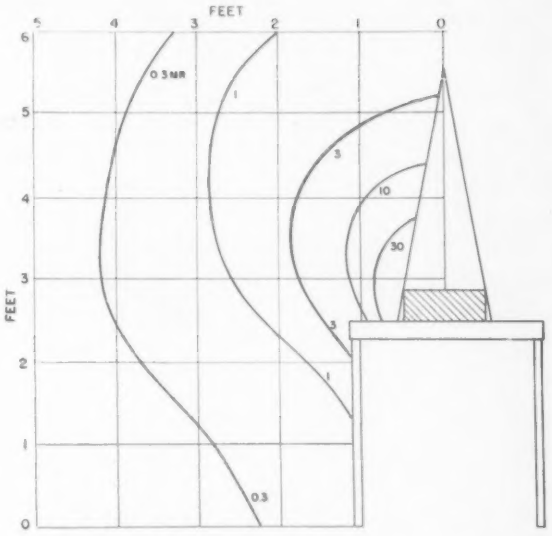

Fig. 2. Isodose curves giving in milliroentgens the radiation conditions which exist during angiocardiography transversely through a typical roentgenographic table. Conditions of exposure were similar to those listed in Figure 1.

When the valve is opened, the piston is drawn down the cylinder, exerting force as it does so on the plunger of the syringe. The plunger of the syringe therefore is driven home and the diodrast injected into the vein.

The entire unit is extremely light, weighing only 3 pounds. On the other hand, it is of sturdy and rugged construction that guarantees reliability of operation. The vacuum method of driving the apparatus

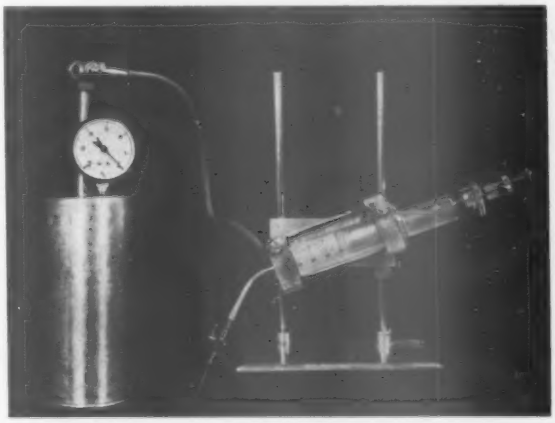

Fig. 3. Angiocardiographic injector device developed for remote control injection of intravenous opaque solutions employed in angiocardiography.

has been chosen not only because this technique makes for simplicity and lightness of construction but because if it is found that the needle has slipped out of the vein for any reason the injection can be instantly stopped by turning the valve on the vacuum bottle. Driving mechanisms which use small motors or similar devices would not only produce heavier and larger instruments, but would be less easily controlled due to the inertia of their parts.

It may be wondered by some how satisfactory the instrument is in routine use and how frequently movement of the patient's arm causes difficulty. These questions of course were anticipated during the design phases of the device. In order to reduce the movement problem as great as possible, the instrument was mounted on a stand which fits beneath the patient's arm. This stand includes straps which securely hold the arm and prevent it from moving unless the patient flexes the arm violently.

In the design of this instrument, careful measurements were made beforehand to ascertain the range of forces normally exerted by the radiologist on the plunger of a syringe during angiocardiographic injection. This range was found to extend from 20 to 35 pounds depending on the speed with which the syringe was emptied. The constructional details of the instrument's vacuum cylinder and piston are such that with a negative pressure of 15 inches of mercury, the piston applies a force of 35 pounds on the syringe's plunger.

Another feature of the injector mechanism is a swivel type of mounting which permits the syringe to be placed either with its long axis parallel to the long axis of the patient's arm or perpendicular to it. It has been found that the latter position is frequently desirable because the blood, when drawn back into the syringe just preceding the injection, floats quickly to the top of the syringe where it does not interfere with the injection. The injector mechanism also includes a switch which is closed by an arm, attached to the instrument's piston, when the injection is completed. This switch may be used to initiate the angiocardiographic exposures if one so desires.

In our hands, this injector mechanism has been found to perform very satisfactorily. The vacuum bottle which operates the device is mounted on a leaded screen, placed near the patient's arm and through which the radiologist may watch the injection. Complete protection is thereby afforded the radiologist with little loss in injection control. Certainly this system removes one of the serious dangers which have attended the angiocardiographic process.

The other hazard, of which radiologists must be cognizant in angiocardiography, is the relatively high mortality rate that exists following the procedure. It has been our experience in somewhat over 600 angiocardiographic injections that one may expect a mortality rate of 1.0 per cent. This rate is considerably greater than that cited by Pendergrass *et al.*[2] for diodrast injections in intravenous urography. It is, however, in general agreement with a recent study by Dotter and Jackson[1] which will be soon published. In their study, Dotter and Jackson obtained data from institutions where angiocardiography is being performed and tentative calculations indicate an average mortality rate of 0.4 per cent for these institutions.

We have had 6 patients die as a result of angiocardiographic procedures. Two of these were patients who died approximately thirty minutes after the administration of a test dose of 1 cc. of 70 per cent diodrast. One of these patients had a severe grade pulmonic stenosis and interatrial septal defect. The other had a severe grade peripheral stenosis and a patent foramen ovale. Both patients encountered respiratory difficulty thirty minutes after the test dose and quickly succumbed in a period of ten minutes. The type of death did not appear to be anaphylactic. Indeed, there is some reason to believe that the excitement attending the preparation of the patient induced the respiratory embarrassment.

The remaining 4 patients died during

angiocardiographic procedure. One of these patients had a transposition of the great vessels and a severe grade peripheral stenosis with arteriosclerotic changes in the smaller arteries of the pulmonary circulation. This patient had three injections of 20 cc. of 70 per cent diodrast and five minutes after the third injection went into a convulsion with marked opisthotonus. Another patient with an Ayerza's type of pulmonary disease encountered severe respiratory difficulty five minutes after the second injection of diodrast. In this case, death occurred approximately fifteen to twenty minutes thereafter. Still another patient with severe grade pulmonic stenosis had a somewhat similar death after a single injection of diodrast.

It is interesting to observe in all of these cases that the patients exhibited either a central or peripheral pulmonary stenosis. Marked cyanosis was also a finding that was common to all. Apparently such a situation is conducive to respiratory difficulty following angiocardiography.

The sixth death occurred during an angiocardiographic examination performed with catheterization of the systemic circulation through the brachial artery. The patient had coarctation of the aorta and a right-sided aortic arch. The catheter was placed in the left brachial artery and the tip was inserted under roentgenoscopy into the aorta. In the manipulation between the roentgenoscopy and the angiocardiographic table the tip of the catheter moved backwards a few centimeters until it occupied a position in what proved to be an anomalous left innominate artery. When the injection was made most of the diodrast flowed into the carotid artery and the patient had an immediate convulsion.

It is interesting to note that in 2 of our 3 deaths that took place after conventional angiocardiography, death occurred after the performance of multiple injections of diodrast. Our customary angiocardiographic technique in patients with congenital heart disease includes the making of at least two series of films, one in the anteroposterior projection and one in the lateral projection. We have found that the additional set of films adds a great deal of diagnostic information in many of the cases that present themselves for examination. Indeed, we have found the extra procedure sufficiently valuable that our clinical colleagues desire that it be done even in the face of the danger that it introduces.

The additional hazard of a second diodrast injection of course may be effectively overcome if one employs an angiocardiographic installation in which two roentgen generators and two angiocardiographic magazines are set up at right angles to one another and are arranged to operate simultaneously. Such an installation will produce two sets of films in right-angled projections on a single injection of diodrast. We have just completed an installation of this type in which the two angiocardiographic magazines are mounted on a hydraulic platform in the manner shown in Figure 4. The magazine that is mounted to receive the horizontal roentgen beam may be moved laterally and vertically to conform to the conditions of positioning imposed by the patient. The patient is rolled over the platform on a radiolucent stretcher for the examination. Two 300 ma. roentgen generators supply the radiation for the installa-

Fig. 4. Twin magazine angiocardiographic installation for making two series of films simultaneously and at right angles to one another on a single injection of diodrast. Unit at left comprises an integrated control unit for operating two roentgen generators with the magazines; unit also provides for electrocardiographic recording during angiocardiography.

tion. Special cross-hatched grids, supplied by the Liebel-Flarsheim Company, prevent scattered radiation from the two roentgen beams from fogging the films.

Now, it is not advocated that everyone who contemplates angiocardiography should install an elaborate system of this type. However, its use by us serves to indicate clearly that every angiocardiographic examination, particularly those in patients with congenital heart disease of the cyanotic type, involves a very real risk.

Many of our deaths undoubtedly are the result of the unusual circumstances that surround many of the patients that come to the Johns Hopkins Hospital for relief from cardiac disorders. However, the angiocardiographic procedure is certainly one that is not without its hazards. Every radiologist should think carefully before he undertakes this examination. The mortality rate is sufficiently high that all other diagnostic procedures should be tried before angiocardiography is undertaken. It is not a procedure that can be taken lightly under our present circumstances at least.

III. SUMMARY

The performance of angiocardiographic procedures presents two principal dangers. One is the excessive radiation exposure to which the radiologist is subjected if adequate precautions are not observed. The second is the high mortality rate of 1.0 per cent which has been found in our experience to accompany angiocardiographic procedures. The radiologist who plans to do angiocardiography should be clearly aware of these dangers to avoid serious accidents.

Johns Hopkins Hospital
Baltimore 5, Md.

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DISCUSSION

Dr. Wendell G. Scott, St. Louis, Mo. As usual, Dr. Morgan has given us another stimulating and interesting paper with very marked advances in the angiographic technique. This is the most appropriate time and stage in the development of angiography to analyze it from a critical standpoint such as he has done here, and as he points out, the primary engineering difficulties have been largely overcome now, and our main efforts must be directed towards making this as safe a procedure as possible.

We have not experienced the mortality rate Dr. Morgan mentioned, but we realize that angiography involves a definite hazard. I agree with Dr. Morgan that all the standard procedures should be done first and, if the diagnosis can be established, then an angiographic injection should not be done. Furthermore, anyone who does angiographic work must have adequate equipment. That means that it must be automatized, that it must take exposures in rapid sequence and that it must be free of mechanical failures.

Dr. Morgan has gone a step farther to help eliminate another hazard which concerns the roentgenologist and the assistants who are taking the films by his ingenious development of a vacuum operated injection equipment that can be placed behind adequate protection. We have used a lead rubber sheet draped down from the tube stand and interposed between the roentgen-ray beam and the operator. I do not believe it offers the protection that can be achieved with the syringe Dr. Morgan has made.

The development of equipment capable of taking exposures at right angles simultaneously should be a great advantage because it eliminates a third hazard—the use of multiple injections. As Dr. Morgan stated, most of his deaths were in patients who had received multiple injections. He has presented a very ingenious unit. I haven't seen it work, but it has been very nicely put together. I am not too well informed about the advantages of it in

cerebral angiography, but I think it offers a similar field for improvement.

This brings us to the last question. What else can be done to make angiographic procedures safer? The answer is the development of newer and innocuous chemicals that are radiopaque. I am pleased to report that several of the chemical and pharamaceutical companies are investigating this problem. Certain promising leads appear to be coming out of their studies and I venture that in the next few years we will be using other media that will be much safer.

It was a real treat to learn about these fine developments that Dr. Morgan has carried out, all directed toward making angiography safer. He is to be congratulated.

Dr. R. S. Stone, San Francisco, Calif. I want to ask Dr. Morgan whether he uses two transformers and two controls when he is taking the right angle film or whether he has an arrangement by which it can all be done from one machine.

Dr. Morgan (closing). I should like to thank Dr. Scott for his very kind comments this afternoon. I think that Dr. Scott's modesty in regard to his developments in angiocardiography would perhaps prevent him from saying too much about the real contributions that he has made in this field; however, the engineering excellence of angiocardiographic equipment, which is now available, is the direct result of his perseverance and ingenuity over a period of years. Certainly, radiologists everywhere owe Dr. Scott a debt of gratitude for this.

In regard to Dr. Stone's question, we have found it more economical to use two separate transformers and control stands rather than the single unit. It becomes a little difficult perhaps to operate this roentgen equipment from a single unit in the range of milliamperage and kilovoltage which we like to employ. It is also a little more simple from the standpoint of flexibility and ease of operation if one employs two units of conventional type rather than a unit, modified to take care of the extra heavy load that this type of procedure imposes.

The principal reason for the control stand that you saw in the last slide was to integrate the roentgen-ray controls in their operation. Actually, that process from an engineering standpoint is very simple.

I am certainly glad to hear from Dr. Scott that a better chemical material for angiocardiography is on the way. Certainly, the big thing that needs to be done at the present time is the development of a new opaque solution that is safe and does not present the toxic situation that now exists.

ARTERIOGRAPHY OF THE AORTA AND ITS BRANCHES BY MEANS OF THE POLYETHYLENE CATHETER*

By JAMES A. HELMSWORTH, M.D., JOHNSON McGUIRE, M.D., *and* BENJAMIN FELSON, M.D.

CINCINNATI, OHIO

AS THE scope of vascular and thoracic surgery is extended, detailed information concerning abnormal morphology of the major vessels is of more than academic interest. For example, knowledge of the length of the constricted segment in aortic coarctation and of the exact relations of the vessels in arteriovenous aneurysm in the neck enables the surgeon to plan accurately an effective operative procedure. Similarly, the differentiation between a mediastinal tumor and an aneurysm may be the determining factor for exploration of the chest.

The present study is based upon experience gained in the performance of arteriography of the aorta or its major branches 26 times in 24 patients. Some features of this method of arteriography have not been previously described. This procedure has been used for experimental investigation only, and it is not recommended as a safe method for general use. Even in the type of investigation to be described its use is ill-advised unless there is strict adherence to the established principles of vascular surgery and an awareness of the dangers associated with intravascular injection of contrast substances.

Arteriography can be accomplished by the injection of radiopaque material into the artery either proximal or distal to the segment to be examined. In the early studies of Sicard and Forestier[23] and Berberich and Hirsch[2] the opaque medium was roentgenographed as it moved in the direction of the blood stream. In some of the later methods[21] the contrast agent was injected into the artery distal to the segment studied, the pressure exerted on the syringe forcing the solution against the arterial current. With the dos Santos method of aortic filling by direct puncture and forceful injection,[22] the flow of contrast medium against the stream, as well as with it, may occur. With all these methods the time interval for obtaining the roentgenogram is greatly limited because the arterial stream rapidly dilutes the contrast medium and sweeps it from the field of study.

The present method is adapted from that of Radner[20] and Brodén, Hanson and Karnell[4] who found it possible to advance the tip of a small catheter within the lumen of an artery. This method multiplies the instances in which it is possible to inject the opaque substance on the proximal side of the arterial segment to be visualized.

TECHNIQUE

The catheter was the most important item of equipment used in this method. A standard woven ureteral catheter was used in several of the early cases but the advantage of its radiopacity was outweighed by the disadvantage of the thickness of its wall. Catheters made of polyethylene tubing* were employed because of the experience of others[13] and proved more satisfactory. Lengths of from 50 to 75 cm. were prepared and a smooth end was made by polishing with emery cloth and by flaming. Special adapters were used to join syringe and catheter.† The inner diameter of the adapter was the same as that of the catheter, maintaining the mechanical advantage of a system of

* Obtainable from Surprenant Electrical Insulating Company, 199 Washington St., Boston, Mass.

† Obtainable from Clay-Adams Company, Inc., 141 E. 25 St., New York, N. Y.

* From the Departments of Surgery, Internal Medicine, and Radiology of the College of Medicine, University of Cincinnati, and the Cincinnati General Hospital. Presented at the Fiftieth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Oct. 4–7, 1949.

relatively large bore. A Robb syringe was used to inject the opaque medium.

Additional experience is required to determine the ideal catheter diameter suitable for a particular artery in an average patient. From Poiseuille's law, which applies to the flow of liquids through small bore tubes, $q = pr^4/-8nl$, where q is the flow in cubic centimeters per second, p the pressure in dynes per square centimeter, r the inner radius of the tube, n the viscosity, and l the length in centimeters, it is apparent that the large bore catheters permit a much more rapid injection. However, it was soon learned that if the catheter scraped along the wall of the vessel, spasm occurred. Now a catheter with an outer diameter several millimeters smaller than the diameter of the arterial lumen is selected and insertion has proved smooth and rapid. The three sizes of catheter now in use are:

No. 1—0.045 inch inner diameter, 0.067 inch outer diameter

No. 2—0.068 inch inner diameter, 0.098 inch outer diameter

No. 3—0.096 inch inner diameter, 0.146 inch outer diameter.

It was possible to detect the presence of a bubble of air through the translucent wall of the polyethylene catheter. This was considered a safety factor of some value since every precaution was taken to prevent the injection of air into the arterial stream. The disadvantage of the radiolucence of the polyethylene catheter was met by filling it with contrast medium. The roentgenoscopist was then able to trace the catheter through its entire course.

The arteries selected for this study were the brachial and the ulnar collateral at the level of the transverse crease of the elbow, and the femoral in the middle third of the thigh below the origin of the profunda.

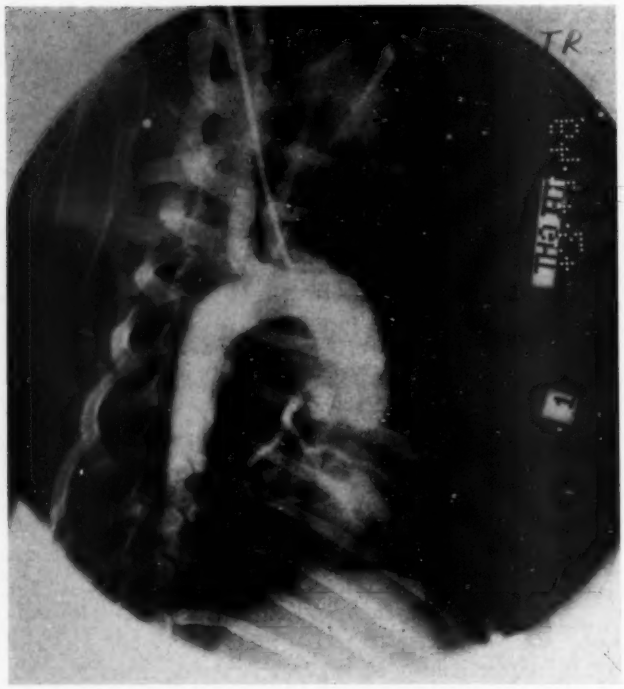
After preparation of the skin, anesthesia was produced by local infiltration. The artery was exposed through a small incision and a 2 cm. segment mobilized by ligation and division of the fine branches. It was essential that the field be entirely free of ooze and that the vessel segment be without hematoma in the adventitia. After a looped sling of ligature silk had been placed about the proximal and distal extremities of the segment, the artery was opened by a transverse incision estimated to be slightly longer than the diameter of the catheter to be inserted. The catheter, filled with heparin-saline solution (70 mg. of heparin to 1 liter of physiological saline) and free of bubbles, was then inserted and advanced toward the heart as tension on the proximal looped sling was relaxed. To prevent the formation of a thrombus within the catheter or about its tip, it was necessary to keep a stream of heparin solution flowing slowly through the catheter. The catheter was advanced until its tip was estimated to be near the desired site of injection. Under roentgenoscopic control the opaque medium, diodrast or neo-iopax, was injected slowly into the catheter until it opacified the tip. The catheter was then advanced or withdrawn to the site of injection. The patient was placed in the position best suited for roentgenographic demonstration of the artery. A fraction of a cubic centimeter of the contrast substance was then injected as a test for sensitivity.

The injection of the contrast medium was made as rapidly as possible with the 50 cc. syringe. This step was carefully timed and usually required from 0.7 to 1.8 seconds. The volume injected varied from 8 to 30 cc. and the Potter-Bucky roentgenogram was usually made as the last cubic centimeter was ejected from the syringe. The factors used for the roentgen exposures were 36 inch target-film distance, 250 milliamperes, 1/20 to 1/10 second, and 90 to 100 kilovolts. A routine test film was made upon the patient's arrival in the roentgen department. The wet film was examined and technical factors adjusted as indicated. Slightly overexposed films were found to be the most desirable.

During withdrawal of the catheter the artery was irrigated with a liberal quantity of heparin solution. When it had been determined that no thrombus was present proximal or distal to the incised segment the artery was repaired. The transverse incision was closed with 5–0 silk on an atraumatic needle with attention to all the details important in the surgery of blood vessels. In several instances repair of the brachial artery was impossible, and ligation and division of this artery was carried out. A simple approximation of the skin margins completed closure of the wound. Anticoagulant was administered only during the examination, as described above. With this method visualization of the aorta and its major branches was undertaken.

CORONARY ARTERIOGRAPHY

Contrast filling of the coronary arteries has been successfully performed in man



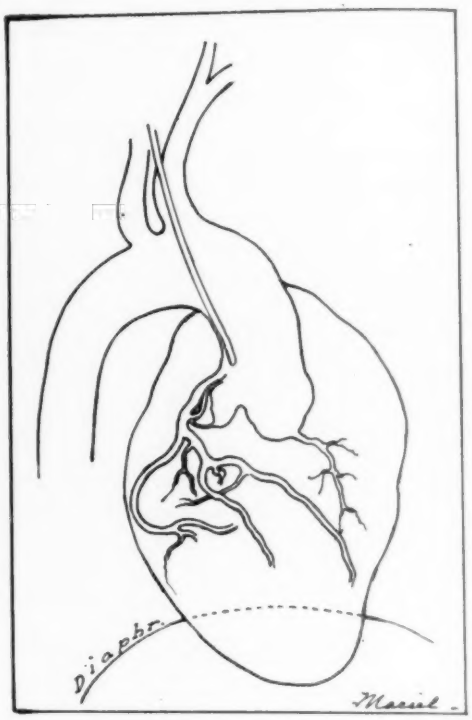
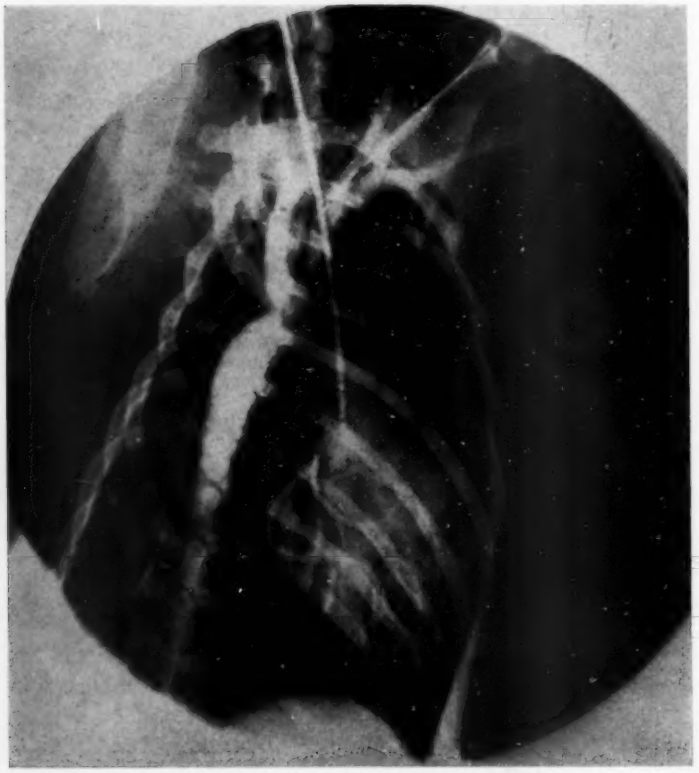


FIG. 1(*A*)



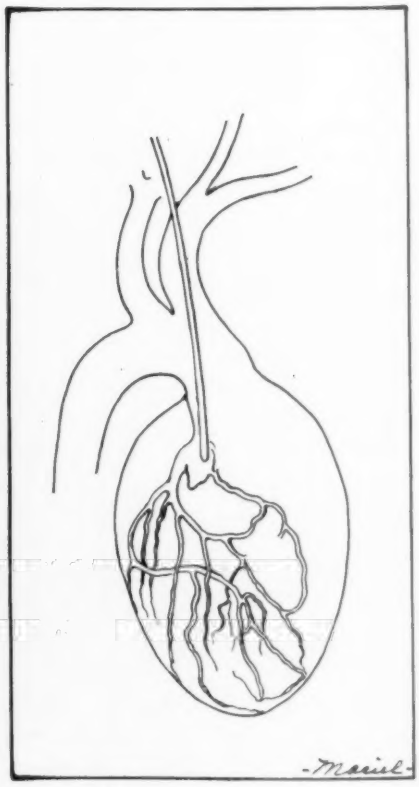


FIG. 1(*B*)

FIG. 1. (*A*) and (*B*) Examples of filling of the coronary arteries in dogs. The catheter extends through the common carotid artery into the ascending aorta.

by needle puncture of the ascending aorta through the chest wall.[17,18] This procedure is dangerous because of possible sequelae, which include pneumothorax, mediastinal emphysema, and pericarditis. Jönsson[14] successfully demonstrated the coronaries in 5 cases during catheter aortography without untoward effect.

In the present attempt at coronary arteriography preliminary experiments were carried out on 5 unselected mongrel dogs. Narcosis was produced with intravenous sodium pentobarbital. The catheter was inserted through either common carotid artery into the ascending aorta, using standard experimental laboratory technique. A serrefine clamp occluded the artery at the distal extremity of the mobilized segment and a looped sling of fine silk was placed about the proximal extremity. Through a small opening in the artery polyethylene catheter No. 3 was advanced toward the aortic valve. Physiological saline was slowly washed through the lumen of the catheter with a syringe to prevent the development of thrombi.

With the animal on the roentgenoscopic table the catheter was filled with contrast medium. Under roentgenoscopic control it was advanced to a level approximately 1 cm. above the aortic valve. Potter-Bucky roentgenograms* were made during and following the injection of varying amounts of 70 per cent diodrast or 75 per cent neo-iopax. After numerous trials it was learned that coronary artery filling was obtainable in the largest number of attempts if the volume injected was in the range of 7 to 15 cc. and if the duration of the injection was in the range of 0.2 to 0.8 second.

In each experiment from six to sixteen injections of contrast medium were made. The largest total volume of contrast substance injected in a single animal was 100 cc. Deleterious effects were not apparent but electrocardiographic tracings were not made during the period of observation. On removal of the catheter the carotid was ligated and a simple wound closure made. The animals were used later for unrelated investigations. The best examples of coronary filling are shown in Figure 1.

Attempts at coronary arteriography were then made on 6 patients. In 4, no filling was obtained. Visualization of some of the circulation was obtained in the other 2 cases, which follow.

Case 1. B. K., a white female, aged eighty-eight, was admitted on February 23, 1949, in coma following a cerebral accident. A history of coronary occlusion one year earlier was obtained from the family. The patient remained deeply comatose throughout her stay in the hospital. On March 10, under local anesthesia, catheter No. 2 was inserted through the left brachial artery into the proximal portion of the ascending aorta. With the patient in the left posterior oblique position 12 cc. of 70 per cent diodrast was injected in 0.5 second. A Potter-Bucky film was obtained at the end of the injection. The procedure was repeated five times. Immediately following the last injection the patient suddenly developed an arrhythmia and, despite emergency treatment, died. Autopsy showed marked cerebral softening, marked arteriosclerosis of the coronary arteries, and an old thrombosis of an anterior coronary branch near the cardiac apex. The coronaries were otherwise patent. There was no evidence that the catheter had traumatized the ascending aorta and no anatomic cause of the sudden death was apparent.

Review of the roentgenograms (Fig. 2) showed the tip of the catheter in the ascending aorta at the level of the aortic valve. Two of the five films revealed filling of the right coronary artery and its branches, but no filling of the left.

Case 11. L. Z., a white male, aged seventy-four, was admitted on February 19, 1949, in a stuporous condition. A diagnosis of multiple myeloma was established. On March 3, with the patient obviously moribund and deeply comatose, catheter No. 2 was inserted through the right brachial artery into the proximal ascending aorta. Ten cubic centimeters of 75 per cent neo-iopax was injected in about 0.7 second with the patient in the left posterior oblique position. The roentgen exposure was

* Roentgen technique: 95 kilovolts, 250 milliamperes, 1/20 second, with the animal in the left posterior oblique position.

made as the injection was completed. The procedure was repeated six times using between 5 and 10 cc. of the contrast substance with each injection. The catheter was removed and the artery repaired. The patient's condition did not appear to change immediately following the procedure but he died six hours later. Autopsy revealed multiple myeloma and lobular pneumonia. The coronary vessels and aorta showed arteriosclerosis of a moderate degree. The coronary ostia were not narrowed. Again, evidence of trauma to the aorta was lacking.

The roentgenograms showed filling of only the proximal portion of the left coronary artery on three of the seven films (Fig. 3).

Comment. Although Cases 1 and 11 died following the procedure, it should be noted that in both instances the patients were already moribund, and that multiple injections of contrast agent were administered. In Case 1 the death must be attributed to the arteriography, but in Case 11 the procedure was probably not at fault. Failure to visualize the coronaries occurred in a number of the attempts in these 2 patients. It is possible that the failures were due to the relatively small quantity of the agent used. Further studies of this problem are being made.

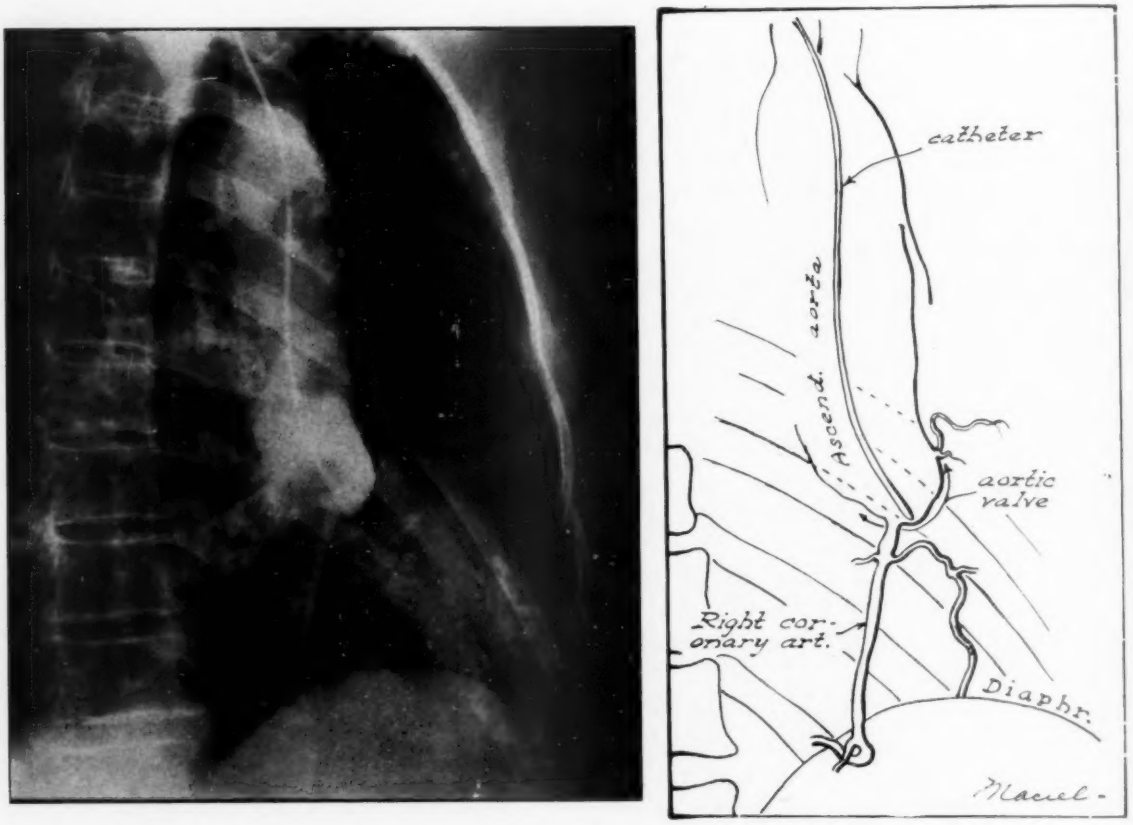


FIG. 2. Case 1. Coronary arteriogram. The tip of the catheter lies at the level of the aortic valve. Note filling of the right coronary and its branches.

THORACIC AORTOGRAPHY

Various techniques have been used for contrast visualization of the thoracic aorta. These include (1) angiocardiography by means of intravenous injection;[7] (2) counter-current injection of dye into the brachial, subclavian, or carotid artery by needle or trocar puncture;[6,16] and (3) needle puncture of the thoracic aorta through the chest wall.[3] These methods have met with varying success and complications. The following 2 cases illustrate

arteriography of the thoracic aorta by means of the polyethylene catheter.

Case III. C. L., a colored male, aged sixty-eight, was admitted on July 31, 1949, because of symptoms produced by a large right superior mediastinal mass. Since the differential diagnosis between mediastinal tumor and aneurysm could not be made, catheter aortography was performed on August 11. Catheter No. 2 was inserted through the right brachial artery into the ascending aorta and two injections were made, the first consisting of 25 cc. of 35 per cent diodrast and the second of 35 cc. of 70 per cent diodrast. The duration of each injection was approximately 0.8 second and a film was exposed at the end of each injection. The second arteriogram was made because of insufficient contrast on the first film. Anteroposterior Potter-Bucky films were made. After the catheter was removed the artery was repaired and a strong radial pulse was then palpable. On August 17, a second arteriogram was made using the original incision. The tip of the catheter was advanced to the level of the innominate artery. Fifteen cubic centimeters of 40 per cent neo-iopax was injected and an anteroposterior film made. A second injection of 15 cc. of 75 per cent neo-iopax was made when the first film showed inadequate contrast. The rate of injection and time of exposure were the same as those of the first arteriogram. During all injections pressure was made on both carotid arteries. The patient did not complain of discomfort during or after either aortogram. The right radial pulse remained normal after the second repair.

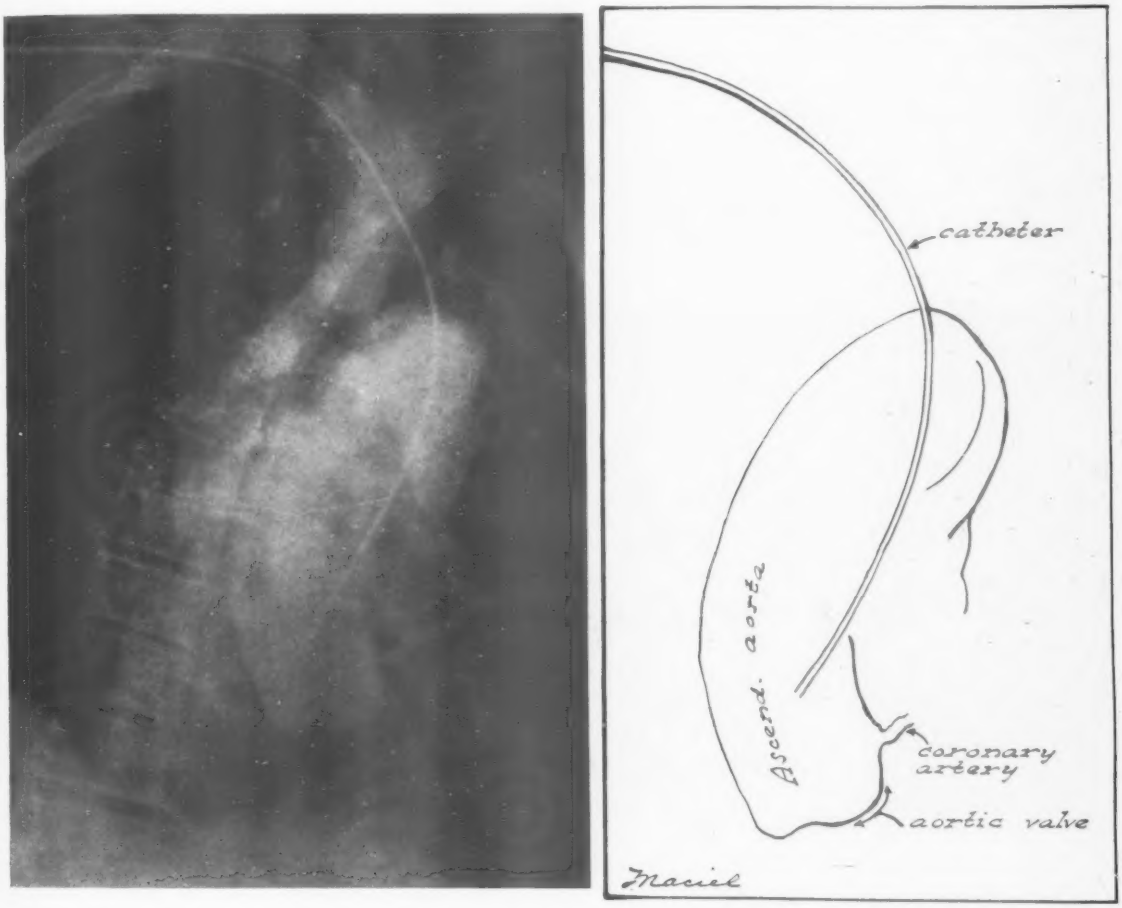


Fig. 3. Case II. Coronary arteriogram. The tip of the catheter lies 2.5 cm. above the aortic valve. Note filling of only the proximal portion of the left coronary artery.

The first arteriogram (Fig. 4*A*) revealed an

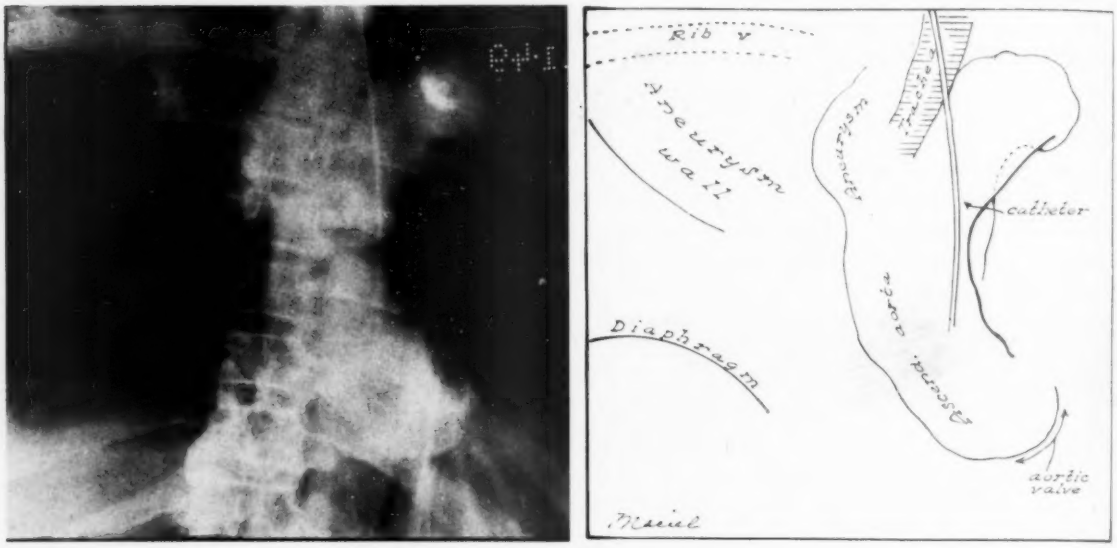


FIG. 4(*A*)

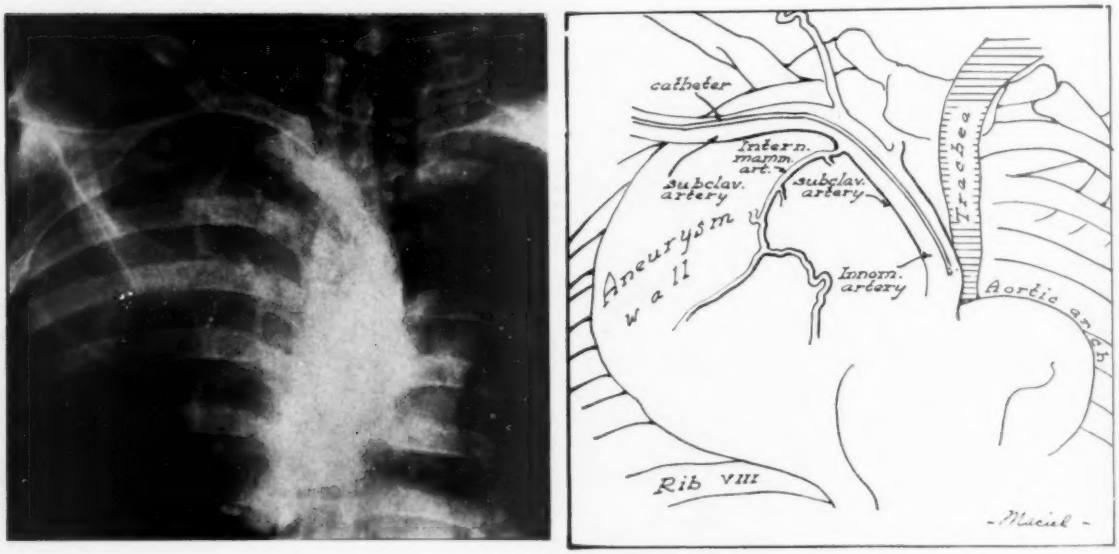


FIG. 4(*B*)

FIG. 4. Case III. Aneurysm of the ascending aorta. (*A*) First aortogram. Note the aneurysmal sac projecting from the right wall of the ascending aorta. The mass adjacent to the aneurysmal sac is believed to represent clot. (*B*) Second arteriogram. The tip of the catheter lies in the innominate artery. Displacement of the innominate and trachea to the left by the aneurysm is shown.

aneurysm arising from the right wall of the ascending aorta. On the second examination (Fig. 4*B*) the innominate and subclavian arteries were normal except for some displacement to the left.

CASE IV. J. E., a colored female, aged ten, was admitted to Children's Hospital on March 1, 1949. A clinical diagnosis of coarctation of the aorta was made. Roentgenographic and roentgenoscopic examination of the heart showed a moderately enlarged aortic knob and absence of notching of the ribs. On March 10, under general anesthesia, catheter No. 2 was inserted through the left brachial artery into the first portion of the subclavian, beyond which point it did not pass. Fifteen cubic centimeters of 70 per cent diodrast was injected in 1.5 seconds and a Potter-Bucky film was exposed at the end of the injection with the pa-

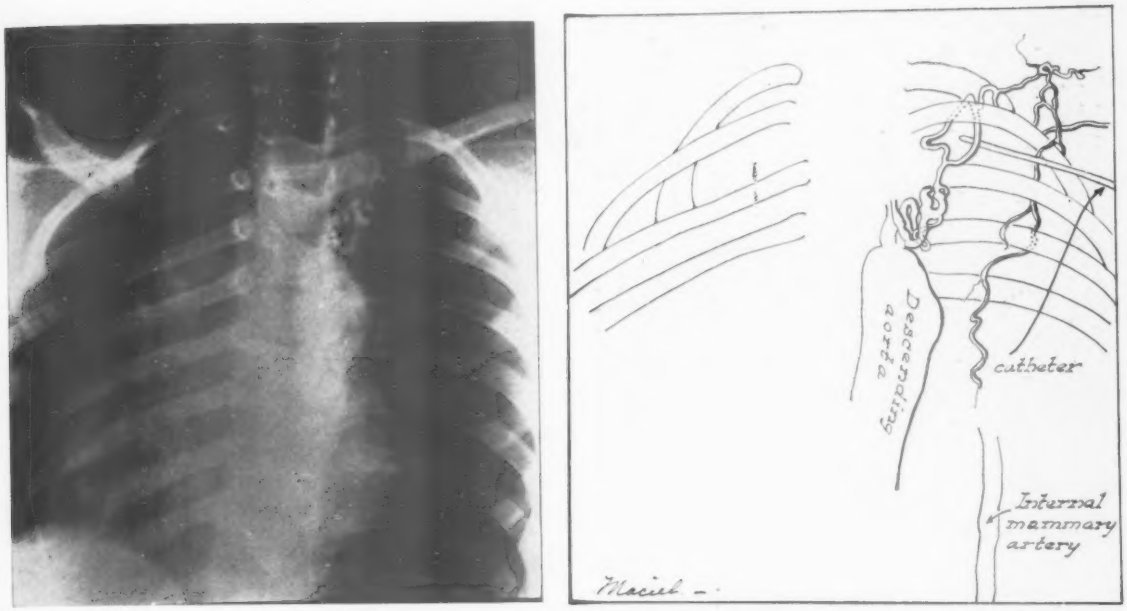


Fig. 5(*A*)

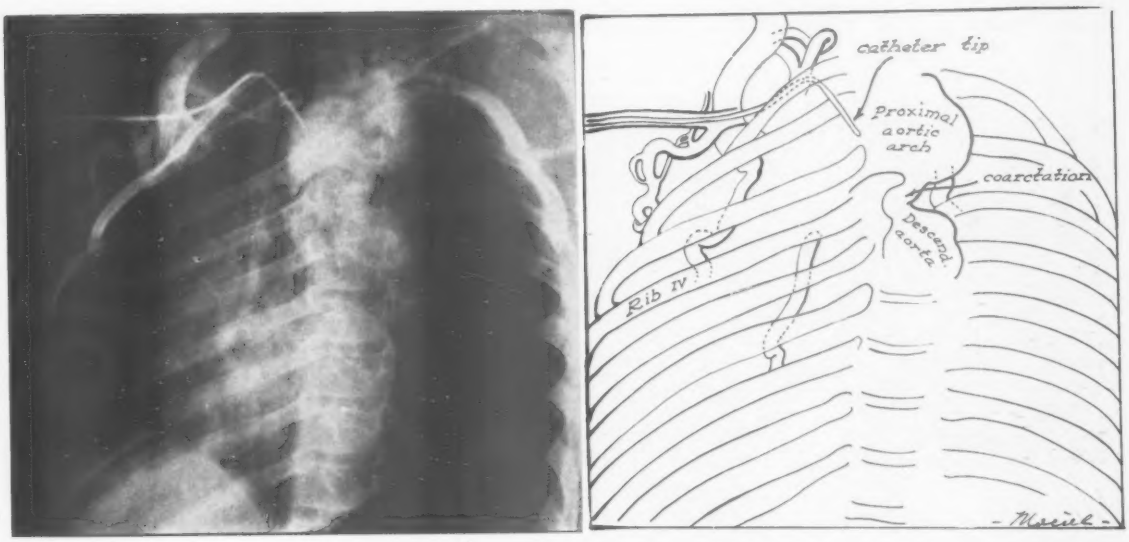


Fig. 5(*B*)

Fig. 5. Case IV. Coarctation of aorta. (*A*) First aortogram. The catheter extends into the left subclavian artery from the left brachial. Note the club-shaped upper end of the descending aorta and the collateral arteries above it. (*B*) Second aortogram. The catheter passes into the ascending aorta from the right brachial artery. Note the coarcted segment.

tient rotated slightly into the right posterior oblique position. On March 16, the procedure was repeated using the right brachial artery. Eight cubic centimeters of 75 per cent neo-iopax was injected and the procedure was repeated twice. No untoward effects were noted. The catheter was removed and the artery repaired.

The first aortogram (Fig. 5*A*) demonstrated numerous collateral vessels and the club-shaped proximal end of the descending aorta. The coarcted segment was not filled. The second aortogram (Fig. 5*B*) showed the tip of the catheter lying in the proximal portion of the aortic arch. Filling of the aortic arch, including the coarcted segment, was obtained.

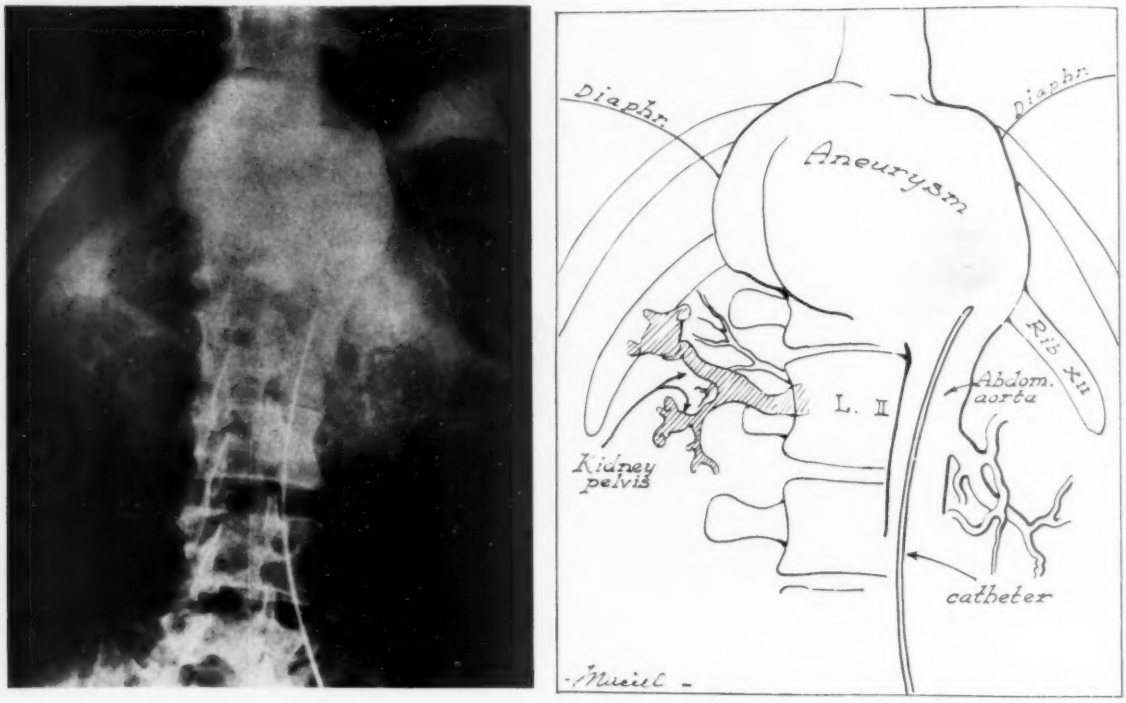


FIG. 6(*A*)

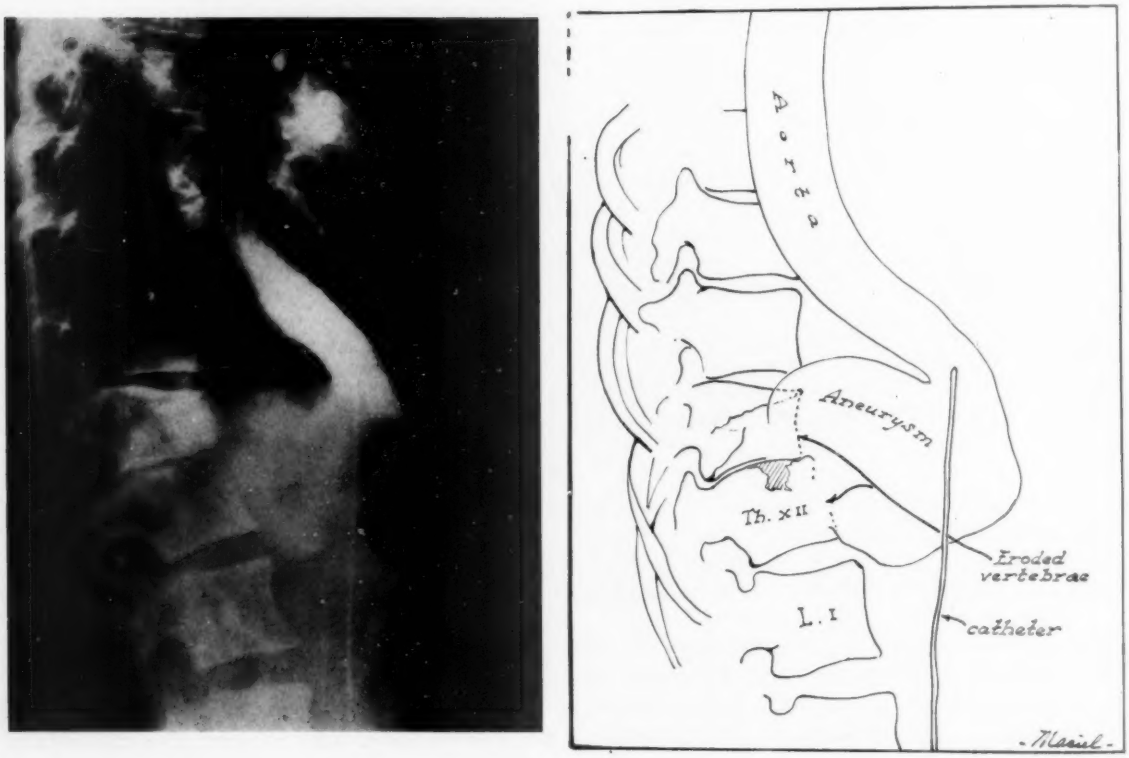


FIG. 6(*B*)

FIG. 6. Case v. Aneurysm of the abdominal aorta. The catheter extends into the aorta from the left femoral artery. (*A*) Anteroposterior view. Note filling of the aneurysmal sac. The pyelogram is the result of an earlier injection of neo-iopax. (*B*) Left lateral view. Note aneurysm arising posteriorly, eroding the vertebrae, and displacing the aorta forward.

Comment. In addition to the demonstration of the aortic aneurysm in Case III and of the coarctation of the aorta in Case IV, successful filling of an aortic aneurysm in a second case and of a normal aorta in 4 cases was accomplished.

ABDOMINAL AORTOGRAPHY

Arteriography of the abdominal aorta has been successfully performed by direct needle puncture through the back,[22] by counter-current injection into the femoral artery,[10] and by retrograde catheterization via the femoral artery.[9] Retrograde catheterization of the abdominal aorta has been used in 3 cases in the present series. In 2 of these, excellent visualization of the normal abdominal aorta was obtained. In the third case, which follows, an abdominal aortic aneurysm was demonstrated.

Case V. W. H., a colored male, aged sixty-four, was admitted on May 14, 1949, because of a severe head injury. Roentgenograms of the dorsal spine revealed a mass in the lower posterior mediastinum eroding the anterior surfaces of the bodies of the eleventh and twelfth dorsal vertebrae. On June 7, catheter No. 2 was inserted into the left femoral artery until its tip extended to the level of the diaphragm. Twenty cubic centimeters of 75 per cent neo-iopax was injected in two seconds with the patient supine, and the film was exposed when 15 cc. had entered the aorta. The catheter was withdrawn slightly and the procedure was repeated. The patient was then turned into the left lateral position and a third arteriogram made. The catheter was removed and the femoral artery repaired. The pulse in the left leg remained normal. The patient tolerated the procedure well.

Roentgenograms (Fig. 6) revealed a large abdominal aneurysm arising from the dorsal aspect of the aorta. The dye-filled aneurysm could be seen in close relation with the eroded vertebral bodies.

Comment. Case V illustrated visualization of an abdominal aortic aneurysm by means of aortic catheterization via the left femoral artery.

Case VI. F. B., a white male, aged forty-six, was admitted on July 25, 1949, because of an acute myocardial infarction. On physical examination it was found that the femoral pulses were very weak and that there were tortuous superficial arteries on the abdominal wall. The patient recovered from the acute coronary attack and, on September 8, catheter No. 1 was inserted through the left brachial artery and into the thoracic aorta to the level of the diaphragm. Twenty cubic centimeters of 75 per cent neo-iopax was injected in ten seconds and an anteroposterior Potter-Bucky film was exposed at the end of the injection. The procedure was repeated using 12 cc. of the contrast medium and an injection time of twelve seconds, the exposure being made after about 10 cc. of dye had been injected. The procedure was again repeated using 12 cc. of contrast substance injected in seven seconds, with the exposure made at the end of the injection. Following each injection the patient noted discomfort in the legs. The catheter was then removed and the vessel repaired. The radial pulse remained normal.

The roentgenogram made following the first injection (Fig. 7*A*) showed filling of the aorta down to the level of the caudal margin of the body of the first lumbar vertebra. Large tortuous collateral arteries, probably mesenteric, were seen on the left side of the abdomen. The films obtained after the second and third injections (Fig. 7*B*) showed filling of large tortuous intercostal arteries and anastomotic extensions to the inferior epigastric. The aorta was faintly and incompletely outlined by the contrast medium. Filling of the lower abdominal aorta was not shown on any of the films. A diagnosis of intrinsic obstruction of the upper abdominal aorta, etiology undetermined, was made.

Comment. This case illustrated obstruction of the abdominal aorta and strikingly demonstrated the collateral arterial circulation. The case also illustrated that it was possible to insert a catheter into the descending aorta via the left brachial artery. This required the use of a small catheter which made rapid injection impossible. Therefore, good contrast in the aorta was not obtained. A pyelogram was obtained on the left but not on the right, suggesting that the obstruction also involved the region of the orifice of the right renal artery.* Visualization of the site of

* At autopsy in May, 1950, thrombosis of the abdominal aorta extending into the right renal artery was found.

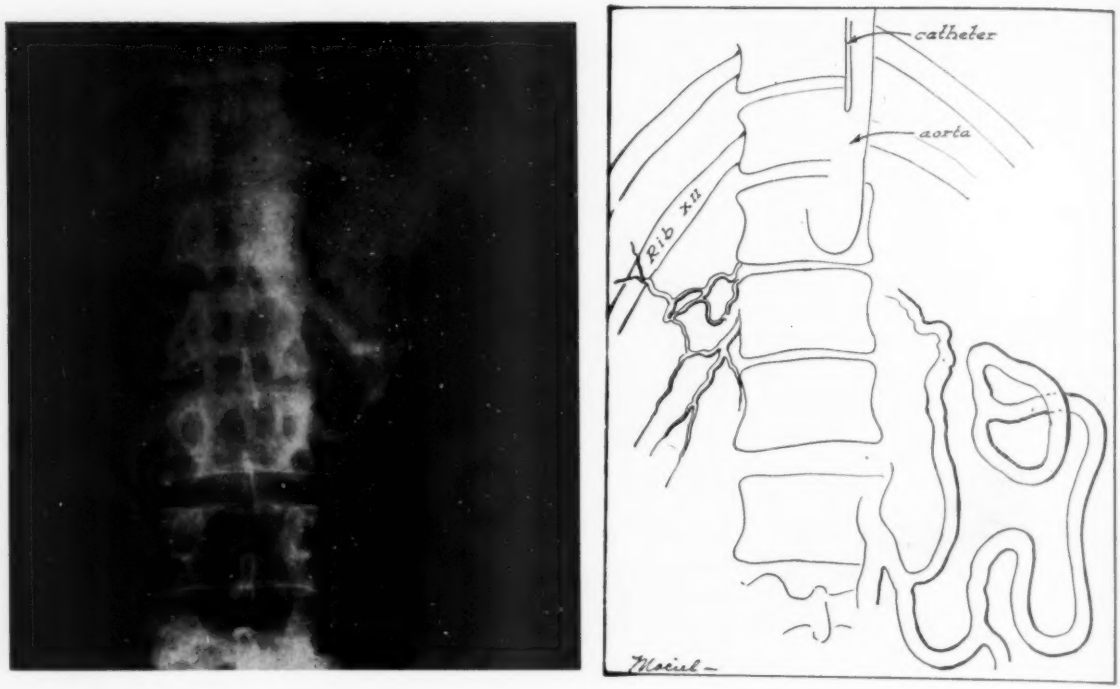

catheter
aorta
Rib XII

FIG. 7(*A*)

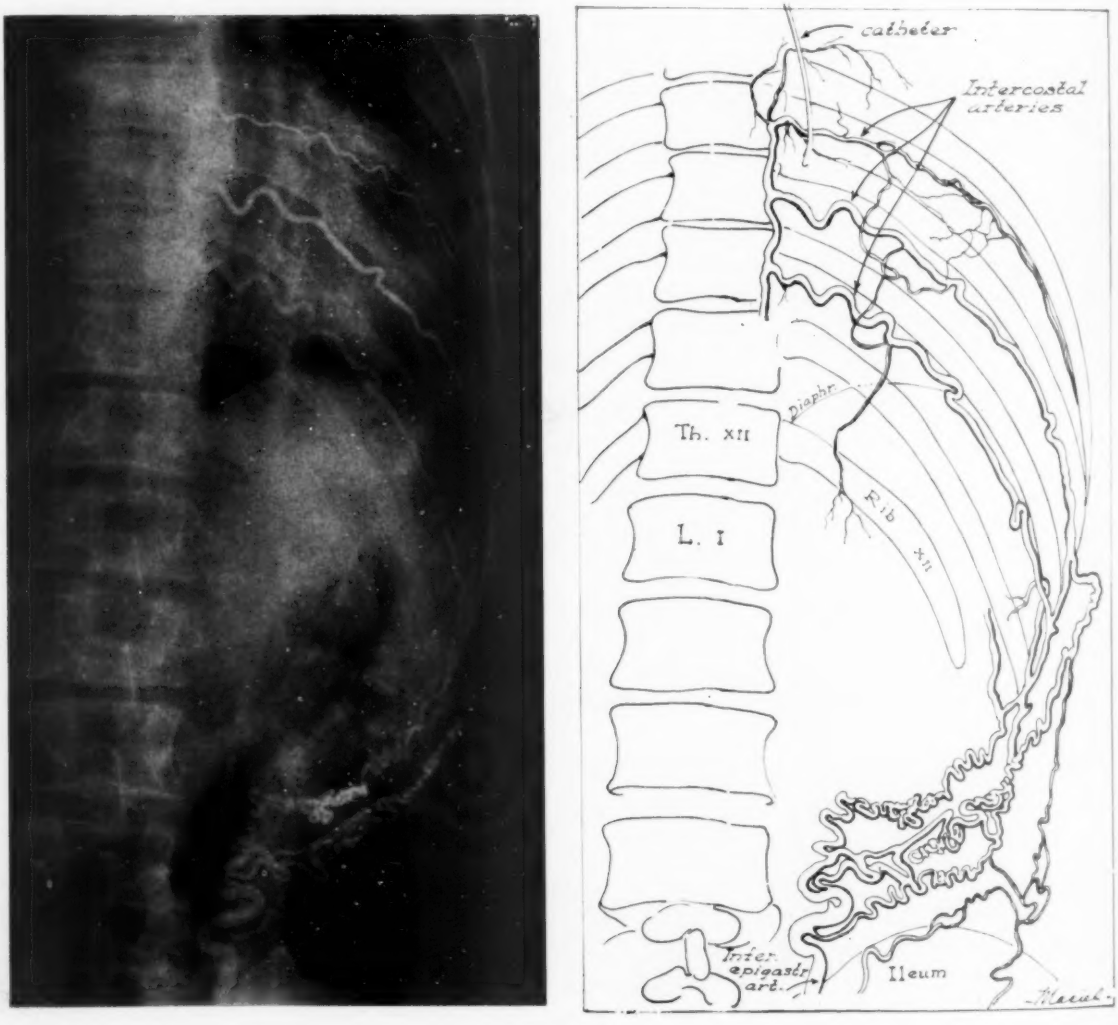

catheter
Intercostal arteries
Diaphr.
Th. XII
L. I
Rib XII
Inter. epigastr. art.
Ileum

FIG. 7(*B*)

an aortic thrombosis has been previously obtained by means of needle puncture of the abdominal aorta[8] but, in the present case, such a procedure would probably have resulted in failure because the obstruction occurred proximal to the usual site of needle puncture.

INNOMINATE, SUBCLAVIAN, AND COMMON CAROTID ARTERIOGRAPHY

Arteriography of these vessels has been attempted with varying success by the following methods: venous angiocardiography; percutaneous needle puncture of the ascending aorta;[17] percutaneous or direct injection of one of these arteries, with filling in the direction of the current or counter-current;[12] and retrograde catheterization of the thoracic aorta. The following cases illustrate our experience with intra-arterial catheterization for contrast visualization of the large arteries of the thorax and their branches.

Case vii. W. C., a colored male, aged seventy-one, was admitted on August 4, 1949, because of the presence of a right superior mediastinal mass on the roentgenogram of the chest. Differentiation between aneurysm and tumor could not be made either clinically or roentgenologically. On August 11, catheter No. 1 was inserted via the right brachial artery into the innominate. Ten cubic centimeters of 40 per cent neo-iopax was injected in 1.6 seconds and an anteroposterior film made. The procedure was repeated. Pressure was exerted on both carotid arteries during each injection. The catheter was then removed and the brachial artery repaired. The pulse remained normal and the patient had no discomfort during or after the procedure.

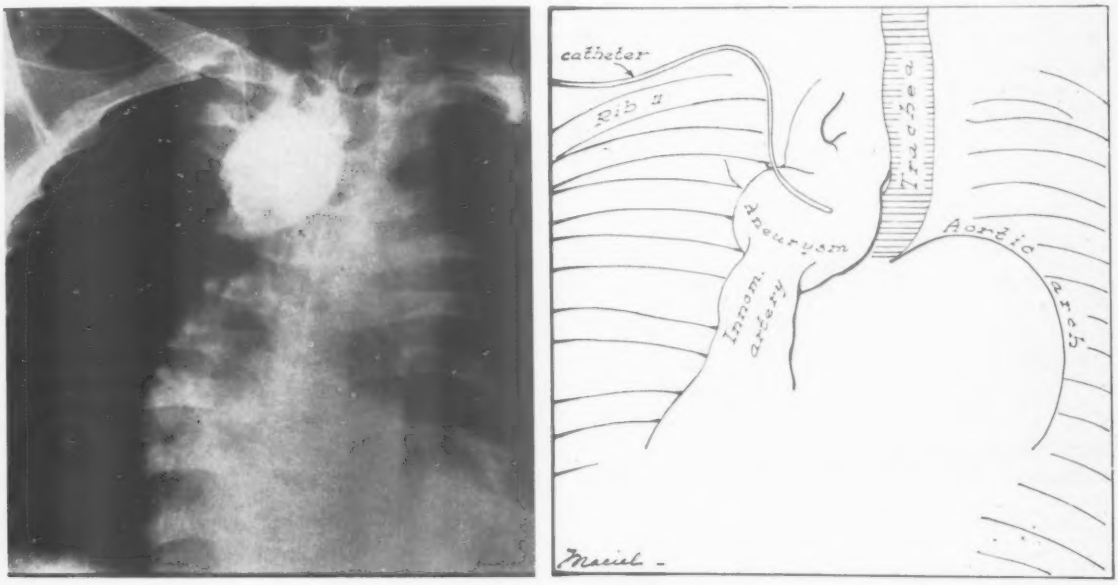


Fig. 8. Case vii. Innominate artery aneurysm. Note the 4 cm. segment of normal innominate proximal to the aneurysm.

Roentgenograms revealed an aneurysm of the distal portion of the innominate artery with a segment of normal innominate, 4 cm. in length, extending from the aneurysm to the aortic arch (Fig. 8).

Comment. In this case the innominate artery catheterization not only established the diagnosis of aneurysm but also demon-

←

Fig. 7. Case vi. Intrinsic obstruction of the abdominal aorta. (*A*) First injection. Note the obstruction in the abdominal aorta and the collateral channels, probably mesenteric arteries. (*B*) Third injection. Note tortuous intercostal arteries and anastomotic extensions to the inferior epigastric artery.

strated that it was technically operable. In another case the use of this method revealed a large aneurysm involving the entire innominate artery, and indicated inoperability of the lesion. Visualization of a normal innominate artery was obtained in 2 additional cases.

CASE VIII. J. S., a white female, aged fifty-one, was admitted on March 23, 1949, because of psychiatric symptoms. Roentgenograms of the skull showed irregular areas of destruction and sclerosis in the frontal bone. Pneumoencephalograms were inconclusive. On April 24, mained normal. Biopsy of the frontal bone revealed infiltration by a meningioma.

Roentgenograms made following the third injection (Fig. 9) showed simultaneous filling of the internal carotid and vertebral arteries, the anterior, middle, and posterior cerebral arteries, and branches of the external carotid. The pericallosal branch of the anterior cerebral artery showed moderate depression and downward concavity indicating a mass in the right superficial frontal region.

Comment. This case illustrated concurrent filling of the carotid and vertebral

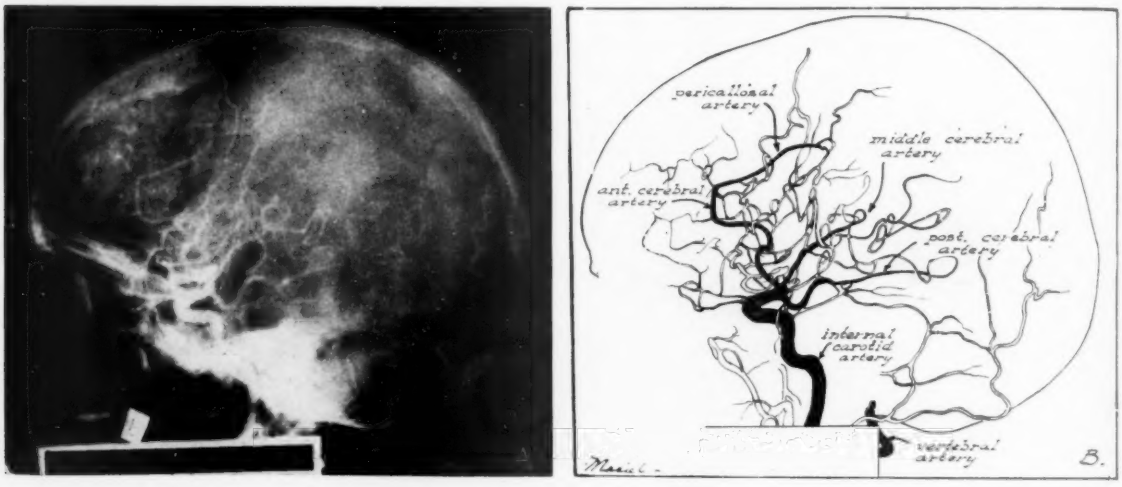


FIG. 9. Case VIII. Simultaneous right carotid and vertebral arteriogram in a case of right frontal meningioma. The diodrast enters these arteries from a catheter placed in the innominate through the right brachial artery. Note the depression of the pericallosal branch of the anterior cerebral artery. Note also the filling of the middle and posterior cerebral arteries.

cerebral angiography was performed by inserting catheter No. 2 into the right brachial artery until the tip entered the innominate. Fifteen cubic centimeters of 70 per cent diodrast was injected in two seconds, and four lateral Potter-Bucky films of the skull were made in rapid succession (seven seconds), the first film being exposed when 7 cc. had been injected. The procedure was repeated using 10 cc. of 35 per cent diodrast injected in 0.7 second. The procedure was again repeated because satisfactory filling was not obtained with the first two injections, and 20 cc. of 70 per cent diodrast was injected in 1.6 seconds with the first of the four exposures being made when 12 cc. had entered. The vessel was repaired after the catheter was withdrawn. No symptoms occurred during or after any of the injections and the radial pulse re-

arteries and their branches by injection through a catheter in the innominate artery. Simultaneous filling of these vessels has not been previously reported. Radner[19] performed vertebral angiography by directing the catheter into the orifice of the vertebral artery from the subclavian. Incidental filling of the vertebral artery occurred a number of times during subclavian and innominate catheter arteriography in the present series. However, roentgenograms of the skull were not obtained in these cases. Two other attempts at cerebral angiography by injection into the innominate artery were unsuccessful.

Case ix. C. G., a white female, aged twenty-four, was admitted on April 14, 1949, in a semicomatose condition following a head injury. On April 18, catheter No. 2 was inserted into the left brachial artery. The tip of the catheter entered the first portion of the subclavian but could not be passed into the aorta. Ten cubic centimeters of 75 per cent neo-iopax was injected in 0.8 second and a film was exposed at the end of the injection. The catheter was removed, then re-inserted, and 3 cc. of 75 per cent neo-iopax was injected under roentgenoscopic control in an effort to determine the exact location of the catheter tip. It was again found to lie in the first portion of the subclavian. The initial procedure was repeated, so that a total of 23 cc. of neo-iopax was given. The patient became very excited at this point but soon quieted. Because the brachial artery had been damaged during the period of excitement it was considered advisable to ligate it. No sequelae developed. The patient was discharged from the hospital on April 26, completely recovered.

The roentgenogram made following the third injection is shown in Figure 10. Excellent visualization of the normal left subclavian artery and its branches was obtained.

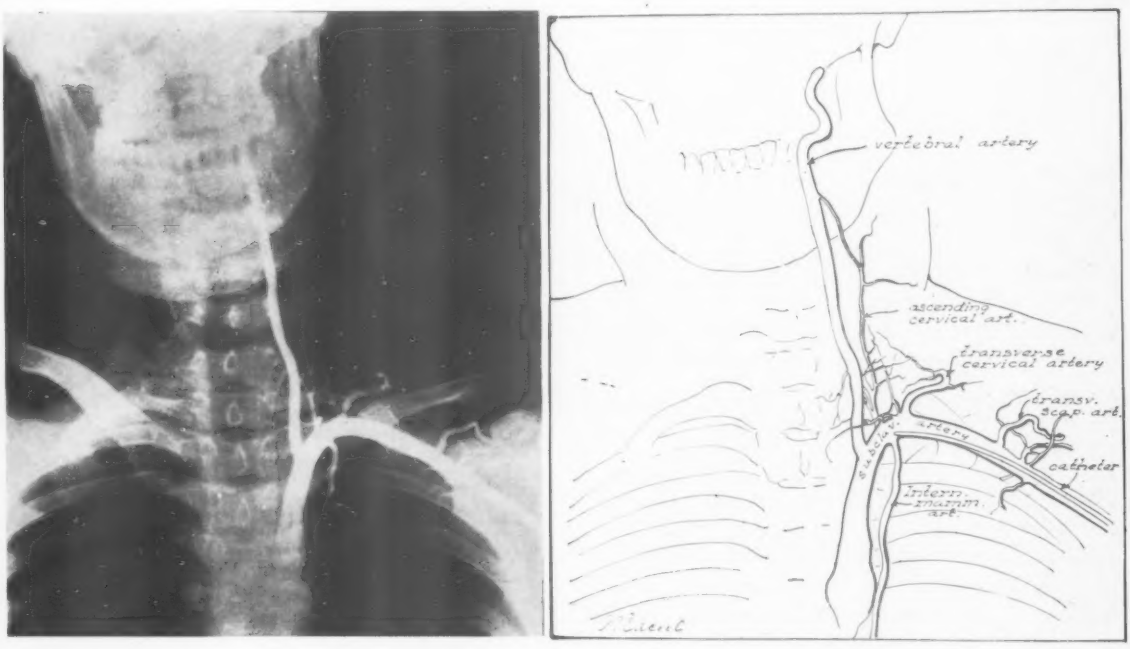


Fig. 10. Case ix. Normal left subclavian artery and its branches. The tip of the catheter lies in the first portion of the subclavian.

Comment. This case is 1 of 8 which showed filling of a subclavian artery and its branches. It also demonstrated failure of the catheter to enter the aorta through the left subclavian artery. This occurred in 2 out of 5 cases.

Case x. S. v. d. H., a one day old white male infant, was admitted to Children's Hospital on October 5, 1948, because of atresia of the esophagus with tracheo-esophageal fistula. On October 6, he was operated on for this condition. Postoperatively, signs suggesting tracheal obstruction appeared. These persisted for about eight months. Because it was possible that the obstruction might be caused by an anomalous right subclavian artery[11] catheterization was performed on June 11, 1949. A 4F ureteral catheter was inserted through the right brachial artery into the innominate artery and a film exposed with the patient supine. No dye was injected. The brachial artery was ligated after removal of the catheter. No sequelae occurred. The patient died on August 21, and autopsy revealed a recurrence of the tracheo-esophageal fistula, but no anomalous right subclavian artery.

The roentgenogram (Fig. 11) showed the

FIG. 11. Case X. Catheterization to exclude anomalous right subclavian artery. Catheter passes into the innominate and ascends in the common carotid artery.

catheter extending well into the right common carotid artery. It had passed through the subclavian, into the innominate, and then up the carotid. On the basis of these findings the possibility of anomalous origin of the subclavian artery was excluded.

Comment. The diagnosis of anomalous subclavian artery was eliminated in the present case by the fact that the catheter entered the right common carotid artery.

CASE XI. A. B., a colored male, aged thirty-two, was admitted on March 15, 1949, with a diagnosis of arteriovenous fistula involving the vertebral artery, resulting from a bullet wound incurred in 1939. On March 22, catheter No. 2 was threaded into the right brachial artery until the tip lay in the first portion of the subclavian. Ten cubic centimeters of 40 per cent neo-iopax was injected in 0.6 second and an anteroposterior Potter-Bucky film of the neck was exposed immediately at the end of the injection. The procedure was repeated twice, but after completion of the second and third injections the exposures were delayed for one and two seconds, respectively. The patient had no complaints during or after the procedure. The brachial artery was ligated after the catheter was removed.

The roentgenogram exposed at the end of the first injection revealed filling of the right subclavian artery and its branches. On the film made following the second injection (Fig. 12*A*) visualization of the innominate and the common carotid was obtained. On the last film (Fig. 12*B*) an aneurysm of the internal carotid was demonstrated and, at the same time, the internal jugular vein was filled, proving the presence of a fistula between these two vessels. A normal vertebral artery was shown.

Comment. This case illustrated that catheter angiography may be of aid in demonstrating the details of an arteriovenous communication in the neck. In a similar case a fistula between the left common carotid artery and internal jugular vein was demonstrated. In a third case arteriography failed to demonstrate an arteriovenous fistula which was later found at operation.

DISCUSSION

The scope of arteriography is extended by this method of catheterization. If the initial arteriogram fails to outline the segment in question the catheter can be advanced or withdrawn and further attempts made. This permits satisfactory visualization with relatively small amounts of contrast substance. In some of our cases difficulty was encountered in directing the tip of the catheter to the desired location. In 1 case the catheter would not pass over the first rib but entered the long thoracic artery instead; in another case it entered the right renal artery during abdominal aortography; in 2 instances it passed into the vertebral or common carotid artery; and on 1 occasion it entered the left ventricular chamber through the aortic valve without apparent damage to the valve.

The most important consideration in a procedure of this type is its effect upon the patient. One death, in a woman aged eighty-eight who was already moribund, was directly attributable to the procedure. Another patient developed convulsions immediately after the injection of contrast medium, but recovered. A third patient, who was semi-comatose at the time of the

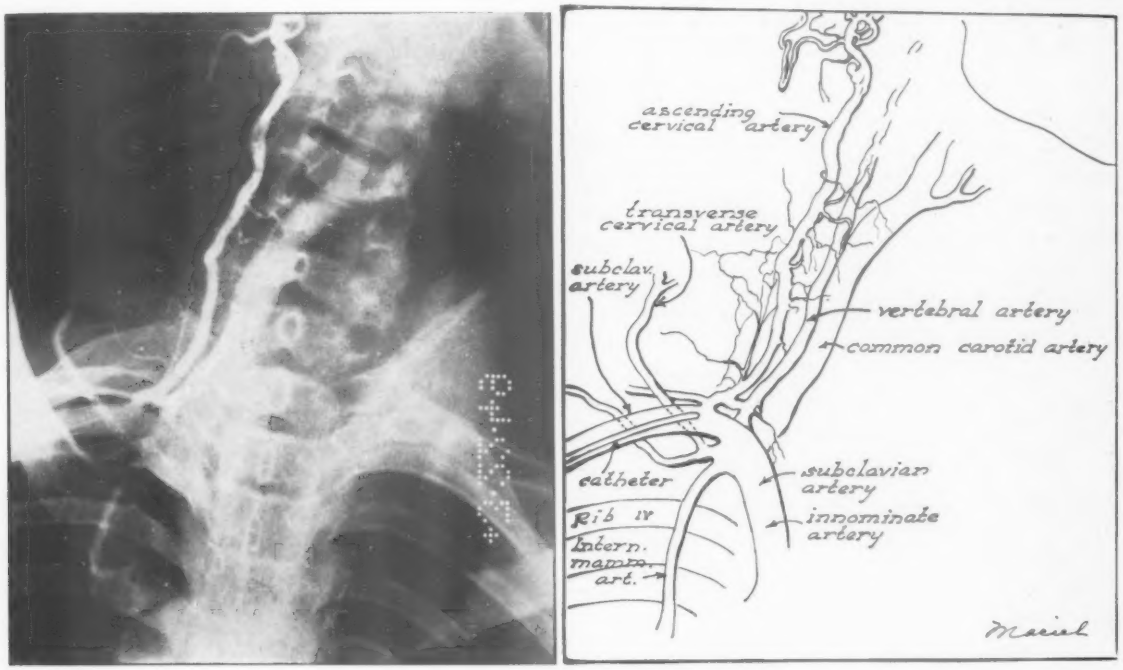


FIG. 12(*A*)

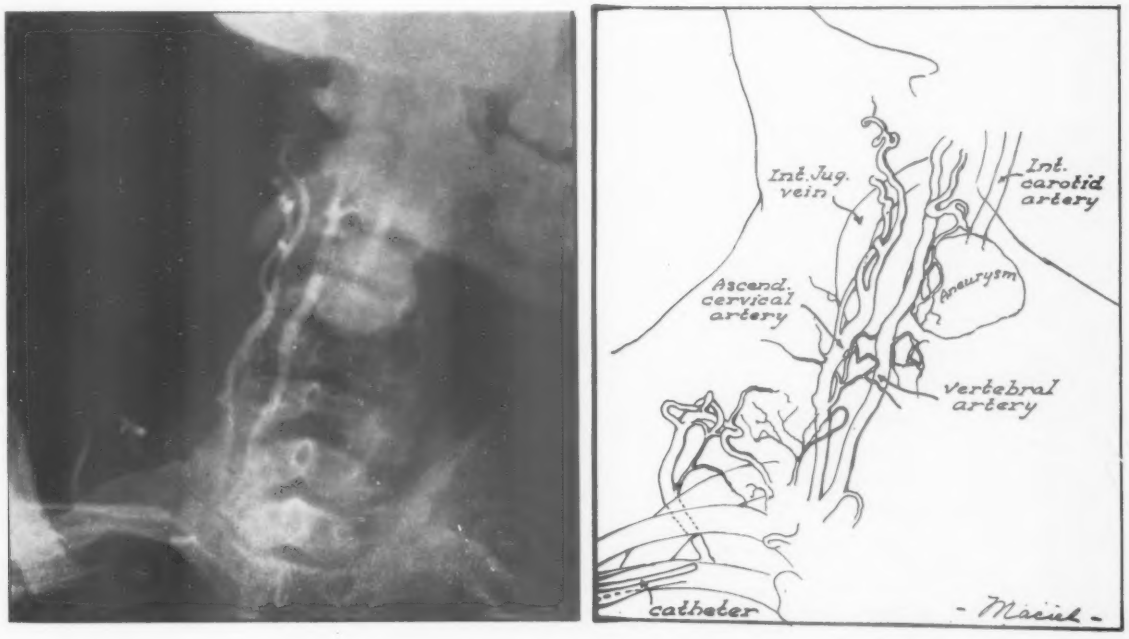


FIG. 12(*B*)

FIG. 12. Case XI. Cervical arteriovenous aneurysm. The tip of the catheter lies in the first portion of the subclavian artery. (*A*) Film made one second after completion of an injection. Neo-iopax fills innominate and right common carotid arteries. (*B*) Film made two seconds after completion of an injection. Note aneurysmal sac arising from the carotid artery and partial filling of the internal jugular vein.

procedure, became excited for a brief period following the injection.

Experience with this method has yielded certain information concerning these reactions. In the first place, there have been no serious symptoms attributable to the

procedure of catheterization itself. In some of the earlier attempts vasospasm, unaccompanied by pain, occurred in the extremity and continued up to thirty-six hours. In every instance this followed the use of a catheter which was too large. In later studies, in which smaller catheters were used, this complication was not encountered, even though repeating the injections sometimes meant that the catheter remained in the artery from thirty to ninety minutes. Thrombosis of the incised artery did not occur when the artery was sutured and even when ligation of the brachial was performed no sequelae developed. In 1 patient the right brachial artery was catheterized on two occasions six days apart, using the same incision. The radial pulse remained normal after both procedures and no complications arose. Bleeding was never a problem since the contraction of the artery sealed the opening of the vessel around the catheter.

In the second place, while all the reactions which occurred did so immediately following the injection of contrast medium, none could be definitely attributed to sensitivity to the dye. All patients were tested for sensitivity by means of the ocular test[1] and by intra-arterial injection of a fraction of a cubic centimeter of the diodrast or neo-iopax, followed by an observation period of several minutes. No reactions occurred to either of these tests. In 2 of the 3 cases showing significant reactions to the procedure, these occurred only after the third and sixth injections respectively. In the third case a convulsion took place following the first injection.

The 1 fatality occurred after the injection of 70 per cent diodrast while the other 2 cases developed symptoms following the use of 75 per cent neo-iopax. In all 3 instances concentrated medium might have entered the cerebral circulation and, as noted by Broman and Olson,[5] cerebral damage might well have been responsible for the reactions. In the more recent cases digital compression of the carotids has been applied during the procedure in order to reduce the volume of medium entering the brain, and no reactions have occurred. It should be noted that in Case VII, despite the use of 70 per cent diodrast for the cerebral angiogram, no reaction occurred. Likewise, in a number of other cases no symptoms resulted from the injection of concentrated dye into the innominate artery.

It is imperative to weigh the dangers of the procedure against the value of the information obtained. Although the present study was basically experimental, the resulting information was often important in the management of the patient and could not have been obtained by completely safe conventional methods. If its dangers can be reduced or eliminated, as by improving the contrast medium, arteriography may prove of value in the elucidation of diseases of the aorta and its major branches.

SUMMARY

1. Experience with catheter arteriograms in twenty-four patients is described and a technique for arteriography with the polyethylene catheter is presented.

2. Eleven cases in which this method was used are reported. These include visualization of aneurysms, arteriovenous fistula, aortic coarctation, and intrinsic aortic obstruction.

3. Filling of the coronary and cerebral circulation is also illustrated.

4. The reactions encountered are enumerated and the hazards of the procedure are emphasized.

The assistance of Dr. B. N. Carter, Dr. K. C. Bebb, and Dr. E. A. Gall is gratefully acknowledged.

Cincinnati General Hospital
Cincinnati, Ohio

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DISCUSSION

Dr. J. Harold Kotte, Cincinnati, Ohio. The technique utilized by Dr. Helmsworth and his colleagues demonstrates how the combined efforts of radiologist, surgeon and internist can lead to more accurate diagnosis of vascular disease. Although this procedure has limited application because of technical difficulty and inherent dangers, the method may be the only one at present whereby diagnosis of certain arterial lesions can be made. By this means vascular obstruction or narrowing can be recognized and localized, aneurysms differentiated from tumors, arteriovenous fistulae visualized and collateral or anomalous circulation studied.

Coronary angiography presents an intriguing problem. One cannot deny the importance of a method whereby narrowing or obstruction of the coronary arteries can be demonstrated. However, the technical difficulties of adequate filling and proper exposure may be hard to overcome. The danger of introducing a foreign, oxygen-free medium into a coronary circulation already seriously compromised by arteriosclerosis is probably great, and anginal pain, dangerous arrhythmias or sudden death are to be feared. Before this study is applied to more patients with coronary disease the effects on coronary flow and the electrocardiogram should be observed in animals and then in normal human subjects, if the results warrant.

The authors are to be complimented on the safety of arteriography in their hands. The avoidance of air embolization, trauma to arterial intima, particularly the aorta, and the lack of postoperative thrombosis indicates the feasibility of further use of the technique.

ANGIOCARDIOGRAPHY

THE PROMINENT PULMONARY ARTERY SEGMENT*†

By J. E. MILLER, M.D.

DALLAS, TEXAS

ANGIOCARDIOGRAPHY has made possible the accurate anatomic diagnosis of variations in the pulmonary artery. This procedure was first made available by Robb and Steinberg[2] in 1938. Since then accurate anatomic and, even more important, accurate physiologic diagnosis of cardiovascular abnormalities has become a relatively simple procedure. The technique of angiocardiography is not difficult and some modification is available to anyone with the usual roentgen-ray equipment. As in any phase of radiology or other branches of medicine, accuracy of interpretation depends on one's experience. This examination is now sufficiently important that every sizable city should have someone capable of performing it.

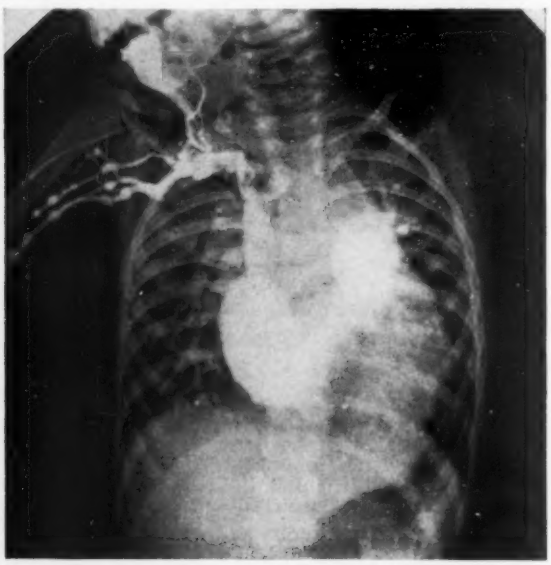

FIG. 1. Pulmonary conus inside left cardiac border. Prominence is due to pulmonary artery.

It is the purpose of this paper to present an angiocardiographic study of those congenital anomalies which produced a prominent pulmonary artery in the posteroanterior chest roentgenogram. The American physician, and this includes many radiologists, has referred to this prominence as the "pulmonary conus" for so long that it will be difficult to convince him that such is not the case. The literature dealing with angiocardiography has numerous references to this fact.[1] In over 200 angiocardiographic examinations many of which were done in frontal projection, the author has never seen the pulmonary conus forming a portion of the left cardiac border. This is true in all types of pathologic states observed as well as in the normal heart. The pulmonary conus is actually a portion of the right ventricle and is situated below the pulmonic valves. The bulge along the left cardiac border represents either the main pulmonary artery or its left branch. Because of this fact, the term "pulmonary artery segment" which is somewhat noncommittal is considered to be the proper term for this structure. Even in the oblique views it is doubtful if the pulmonary conus actually forms a border of the cardiac silhouette. It is probably necessary to have a lateral projection before one should speak of the pulmonary conus as a border of the heart. Figure 1 shows the pulmonary conus well inside the left cardiac border with the pulmonary artery forming the prominence along the left cardiac border.

Where many cases of congenital heart disease are seen, six lesions stand out as a cause of prominence of the pulmonary artery segment. These are: (1) idiopathic dilatation of the pulmonary artery; (2) pulmonary artery aneurysm; (3) patent ductus arteriosus; (4) interatrial septal de-

* From the Departments of Radiology of Parkland and Baylor Hospitals and the Southwestern Medical School of the University of Texas. Presented at the Fiftieth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Oct. 4–7, 1949.

† The author wishes to thank the Winthrop Chemical Company for furnishing the 70 per cent diodrast which made this investigation possible.

fect; (5) Eisenmenger's complex; and (6) post-stenotic dilatation of the pulmonary artery.

Idiopathic Dilatation of the Pulmonary Artery. With the advent of survey films of the chest, patients who have an unusually prominent pulmonary artery segment have been referred for diagnosis. These patients have received various diagnoses despite the fact that they have no symptoms or clinical findings. The two most common diagnoses have been tuberculous hilus lymphadenitis and bronchiogenic carcinoma. Angiocardiography readily shows this prominence at the left hilum to be the pulmonary artery or its left branch. Since there is no clinical abnormality and since no cause for the prominence can be discovered by angiocardiography, these individuals are said to have idiopathic dilatation of the pulmonary artery. Figure 2 shows a prominent pulmonary artery segment discovered during a routine examination. Figure 3 shows the angiocardiogram proving that this prominence is due to the pulmonary artery and its left branch.

Pulmonary Artery Aneurysm. Six definite aneurysms of the pulmonary artery are included in this report which have not been reported elsewhere. Aneurysms of the pulmonary artery are not difficult to diagnose by means of roentgenoscopy. One of the patients included in this group had a thoracotomy elsewhere with a preoperative diagnosis of bronchiogenic carcinoma. A number of individuals have been seen who represent a transition between idiopathic dilatation of the pulmonary artery and pulmonary artery aneurysm. Only those have been designated as aneurysm where there is no doubt that this is the proper classification. Only one of these aneurysms was associated with a patent ductus arteriosus. The aneurysm involved the right pulmonary artery and the ductus opened into this vessel. None of the patients with pulmonary artery aneurysm had ever had syphilis so far as could be determined. Figure 4 shows an aneurysm of the left pulmonary artery which was diagnosed by roentgenoscopy. Figure 5 shows the demonstration of this aneurysm by contrast material.

FIG. 2. Prominent pulmonary artery segment. No signs or symptoms present.

FIG. 3. Idiopathic dilatation of the pulmonary artery.

Patent Ductus Arteriosus. Prominence of the pulmonary artery segment in this anomaly has been overemphasized. In my experience, an abnormal pulmonary artery segment is observed in slightly over 50 per cent of the cases. It might be well to state

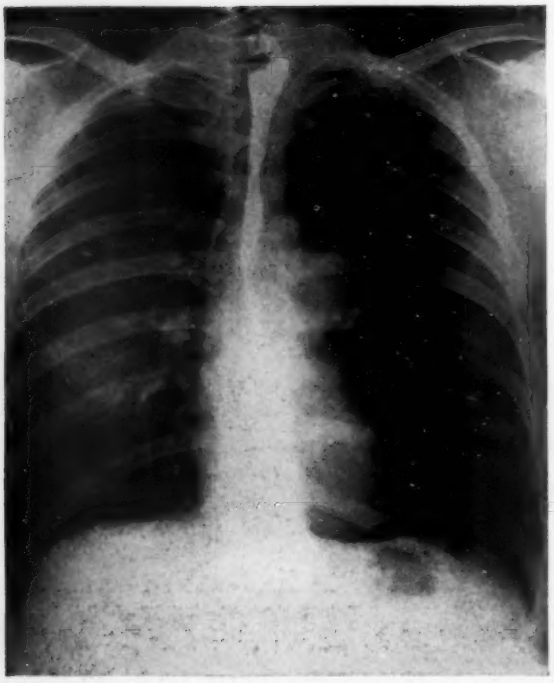

FIG. 4. Aneurysm of the pulmonary artery.

here that the pulmonary artery segment may be quite prominent in certain individuals and still be entirely normal. This is especially true in children and individuals

FIG. 5. Same patient as in Figure 4, with the aneurysm opacified.

of the asthenic habitus. The hilus dance of patent ductus arteriosus is a relatively unimportant sign and is certainly found in less than 10 per cent of patients. The angiocardiogram frequently shows the main pulmonary artery bulging above the bifurcation, as shown in Figure 7. One of the most important diagnostic signs of patent ductus arteriosus is the evagination of the aortic arch at the point of attachment. This sign was first described by Steinberg, Grishman

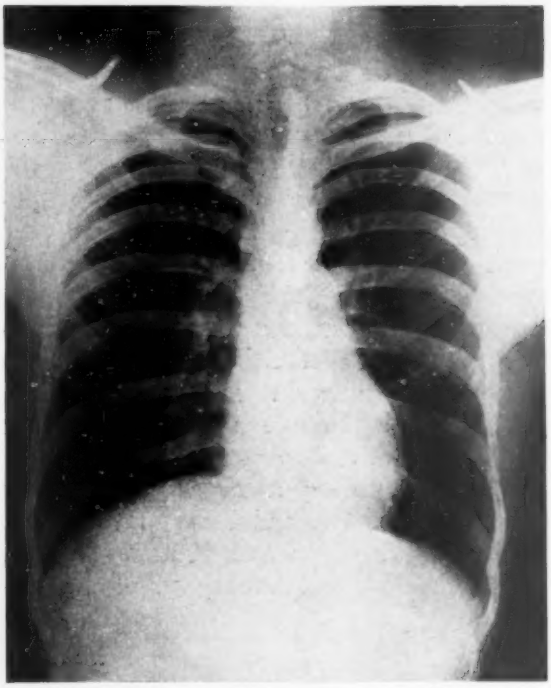

FIG. 6. Patent ductus arteriosus. The heart appears to be normal.

and Sussman,[4] and has been identified in almost all of our cases. Revisualization of the pulmonary vessels has been readily seen on numerous occasions. The ductus arteriosus has been definitely visualized twice. Figure 6 shows a normal cardiac contour in the patient showing the prominent aortic evagination.

Interatrial Septal Defect. Interatrial septal defect usually causes a rather large pulmonary artery segment. This is not invariable, however, since a number of cases of this defect have been seen without any suspicion from the usual films that this abnormality existed. There is a tremendous

recirculation of blood through the right side of the heart in interatrial septal defect. This accounts for the large pulmonary artery and its peripheral vessels as well as right atrial and ventricular enlargement. This is one of the conditions which regularly produces a hilus dance. All of these findings are exaggerated with the addition of mitral stenosis producing the so-called Lutembacher's syndrome.

The left atrium is not enlarged in either instance since it is under no unusual strain. The angiocardiogram shows a continuous visualization of all of the chambers once the left atrium and left ventricle have become opacified. Most of the contrast material returning to the left atrium from the lungs is shunted into the right atrium, to the right ventricle and again to the lungs. In six to fifteen seconds there is a gradual diminution of opacification of all four chambers. The aorta is usually not well visualized in this condition because sufficient contrast material is not received by the left ventricle within a short period of time. The aorta is usually small or hypoplastic. Occasionally in small children the pressure of the injection will force contrast material from the right atrium into the left atrium and the actual defect is then visualized. This phenomenon may be exaggerated when tricuspid stenosis or atresia is present. Figure 8 shows the usual appearance of the cardiac silhouette with its prominent pulmonary artery segment and hilus vessels as well as the angiocardiographic appearance with opacification of all chambers. Figure 9 shows a patient with Lutembacher's syndrome with extreme dilatation of the main pulmonary artery and hilus vessels. This patient had the most extreme hilus dance ever seen by this observer.

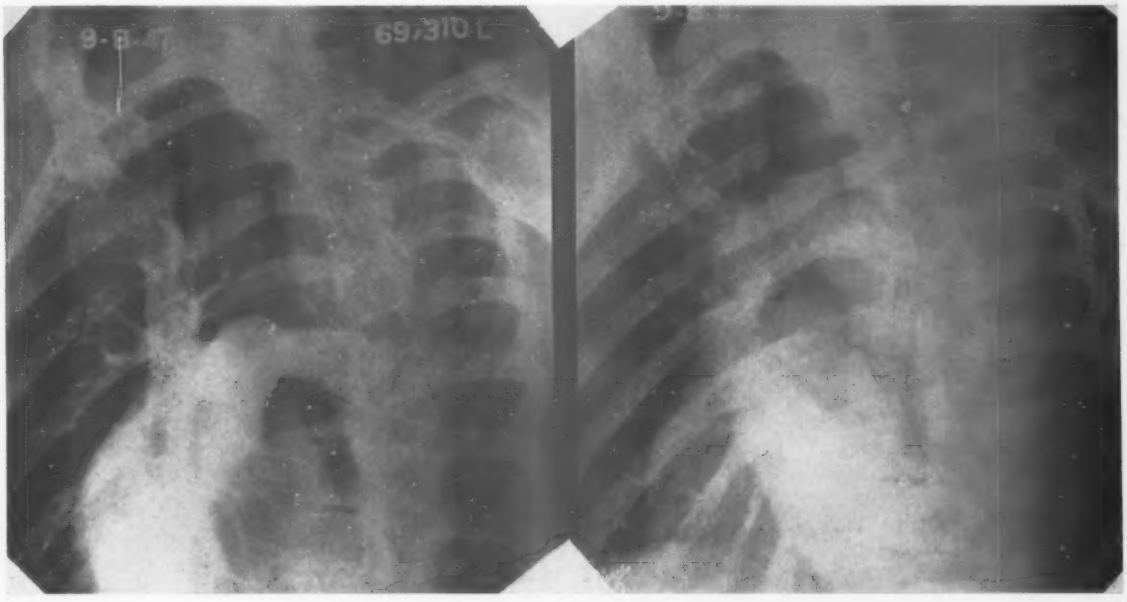

Fig. 7. Patent ductus arteriosus. Pulmonary artery bulges above bifurcation. Evagination from aortic arch is a frequent finding.

Enlargement of the pulmonary artery segment in isolated interventricular septal defect is quite unusual. This condition is not included, therefore, as a cause of pulmonary artery segment prominence. This is contrary to the experience of others.

Eisenmenger's Complex. In Eisenmenger's complex the angiocardiographic findings may be quite similar to those seen in tetralogy of Fallot. This is especially true if one is willing to admit that the pulmonary artery may be normal in size rather than dilated. It is not always easy to find a point of stenosis in tetralogy of Fallot and

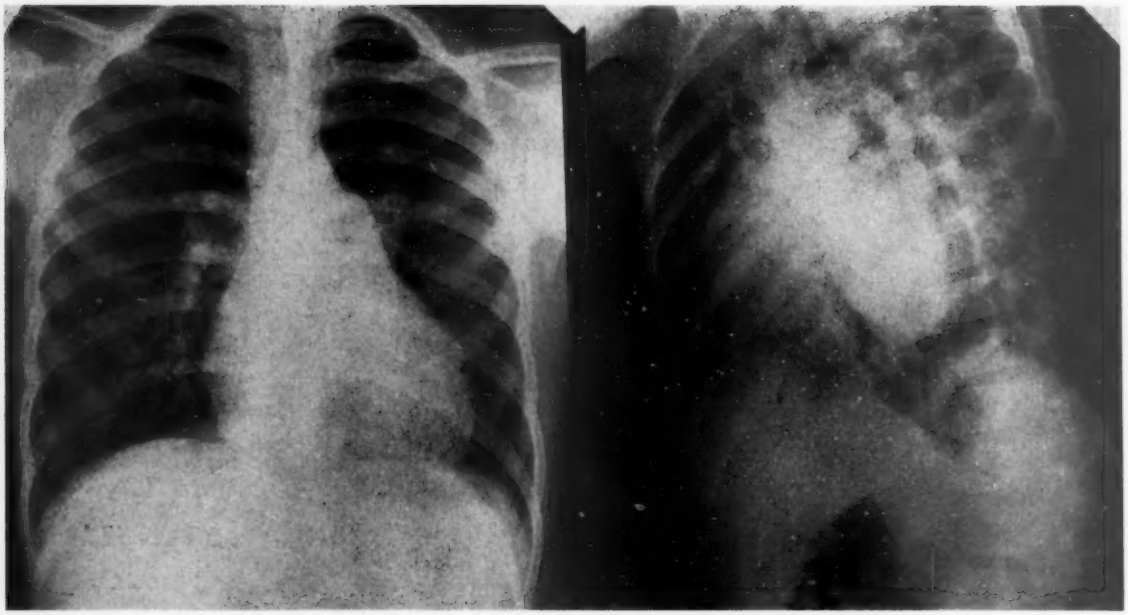

FIG. 8. Interatrial septal defect. Angiocardiogram shows continuous opacification of all chambers.

sometimes the pulmonary arteries, at least peripherally, appear to be normal in size. A number of cases have been seen where there is actually post-stenotic dilatation. For this reason, it is possible that a purely angiocardiographic diagnosis of Eisenmenger's complex may be erroneous. Certainly if there is any clinical reason to suspect an error, the patient should be given the benefit of thoracotomy and direct measurement of the pulmonary artery pressure should be taken. If the pressure is below 350 mm. of water it may be feasible to do an anastomosis. Occasionally, cases of Eisenmenger's complex are seen where pulmonary artery dilatation may be tremendous. We have recently seen such a case where the dilatation was comparable to that seen in a well advanced Lutembacher's syndrome. Patients with Eisenmenger's complex who have a large pulmonary artery and peripheral pulmonary vessels usually have a hilus dance. Figure 10 shows the appearance of the pulmonary artery segment and peripheral vascular shadows in a patient with Eisenmenger's complex. The postmortem examination in addition showed an anatomically patent ductus arteriosus which was considered to be physiologically non-functional. Figure 11 shows the angiocardiogram of this patient in two projections. The large pulmonary artery is visualized as well as the aorta and left ventricle in an early phase of the examination.

FIG. 9. Lutembacher's syndrome. Extreme dilatation of the pulmonary artery. Note tremendous hilus and peripheral vessels on the right.

Fig. 10. Eisenmenger's complex.

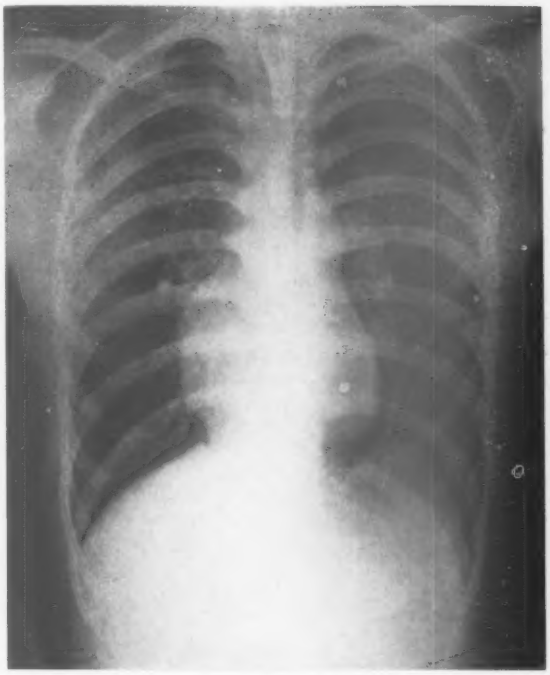

Fig. 12. Post-stenotic dilatation of the pulmonary artery showing enlargement of the heart to the right.

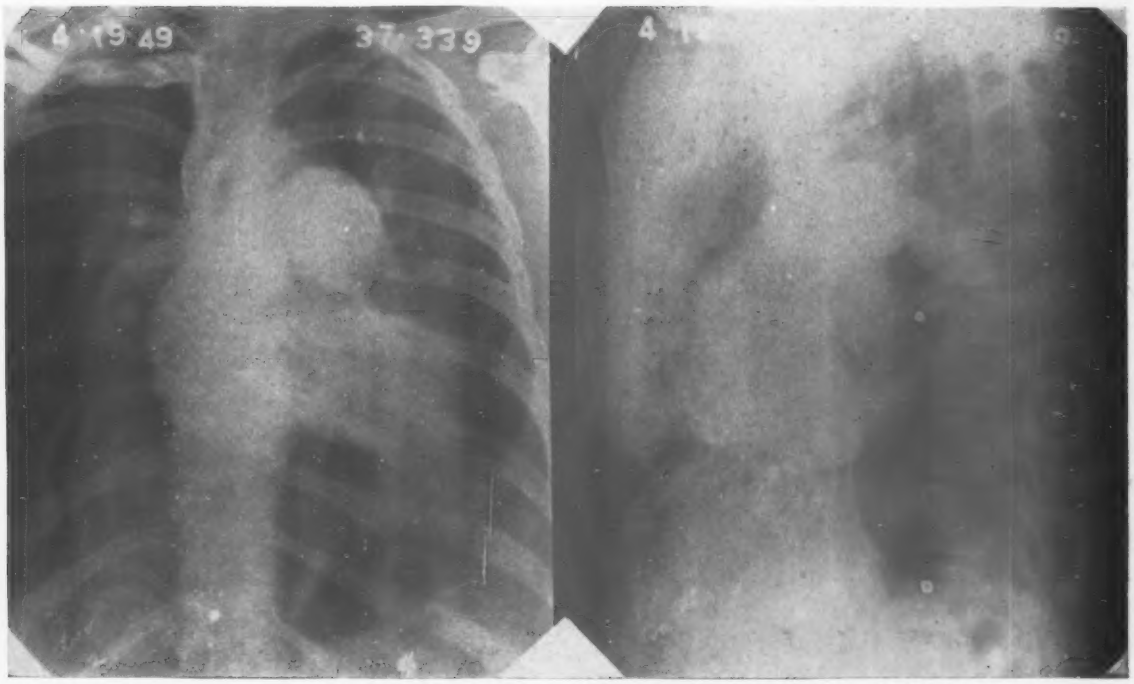

Fig. 11. Angiocardiograms on same patient in two projections. Note aorta and left ventricle on film on right in the anteroposterior projection.

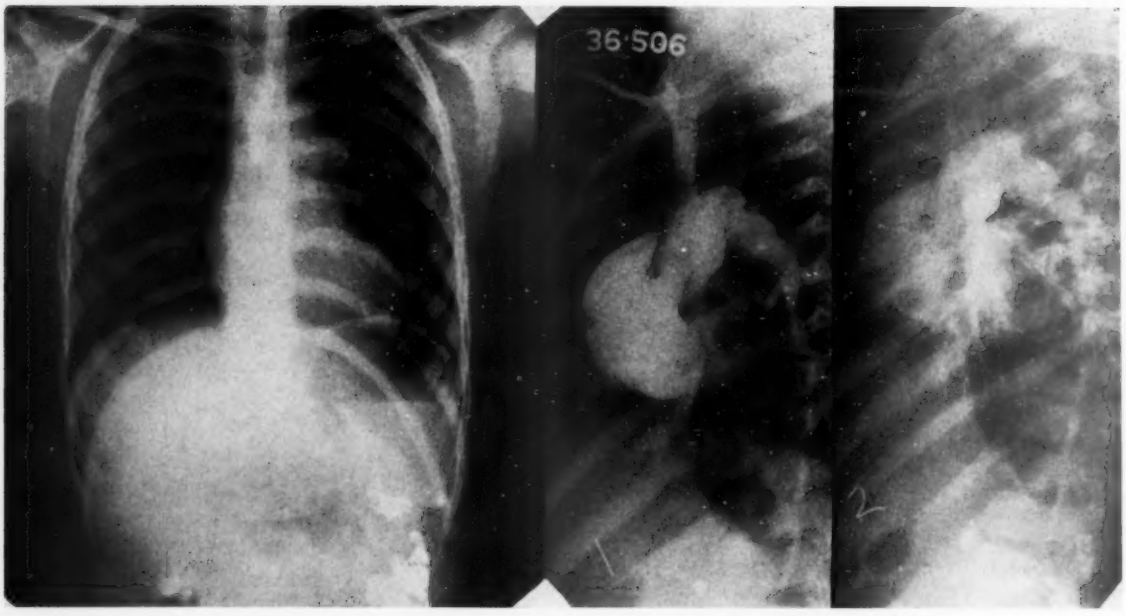

FIG. 13. Post-stenotic dilatation of the pulmonary artery. Pulmonary artery segment unusually high. Typical angiocardiographic appearance of the pulmonary artery.

Post-stenotic Dilatation. Seven cases of isolated pulmonary stenosis have been seen. In each instance, post-stenotic dilatation of the pulmonary artery was present. It may be possible to make this diagnosis or at least suspect it from the posteroanterior film alone. This is one abnormality in which there is disproportionate enlargement of the heart to the right. Figure 12 shows the enlargement of the heart to the right of the spine. In addition, the prominent pulmonary artery segment is somewhat different from that seen in other conditions. It is unusually high and obscures the aortic knob. In fact, it usually extends as high as the aortic arch. Figure 13 shows a fairly characteristic appearance of the angiocardiogram in post-stenotic dilatation of the pulmonary artery. It is sometimes possible to recognize the point of stenosis. It may be the main pulmonary artery or the pulmonic valves. In one of the cases, the stenosis was subpulmonic (Infundibular or conus stenosis). This patient also had a dilated pulmonary artery beyond the stenosis.

SUMMARY

The six congenital anomalies causing enlargement of the pulmonary artery segment have been discussed. Their roentgen and angiocardiographic features are presented. It is again stressed that the term "pulmonary artery segment" should be used to replace the inaccurate term "pulmonary conus" in referring to the prominence along the left cardiac border.

Dallas City-County Hospital System
Dallas, Texas

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DISCUSSION

Dr. Fred J. Hodges, Ann Arbor, Michigan. We have just listened to an excellent dissertation which indicates that Dr. Miller is a deep student of cardiac circulation. He has done an excellent job this afternoon in presenting to us many of the very difficult problems to be met in analyzing films of a sort which most of us are unable to produce.

I agree quite whole-heartedly that the pulmonary conus certainly does not form a part of the left cardiac border.

Although we were listening to a discussion of the pulmonary artery, the entire matter of angiographic interpretation has of necessity been well covered. To a very large extent that particular vessel is the center of interest. In the thoughtful analysis of rather confusing vascular and cardiac chamber shadows, the pulmonary artery deserves first consideration. This has been our experience and the experience of a great many others.

I would like to point out that when extremely rapidly repeated exposures are made during the course of flow of opaque material through the heart, variability of the caliber of the pulmonary outflow tract can be recorded. We have observed that in making exposures at half second intervals throughout the entire cardiac cycle considerable variation in the width of the pulmonary outflow tract will be seen. If one depends upon occasional views only it is easy to report evidence of pulmonic stenosis which a few seconds later will have disappeared completely.

We have been treated to an excellent exposition of the analysis of angiocardiograms this afternoon.

Dr. Merrill C. Sosman, Boston, Massachusetts. I would like to say just a few words on this subject from a different viewpoint, that of cardiac catheterization, but first I would like to point out that the ultimate objective of all of these very complicated time-consuming and sometimes dangerous procedures is to learn enough about these conditions so that we can go back and refer that knowledge to the original, simple, uncomplicated examination and know more about what we are seeing and finding. That is what we are trying to do at the Peter Bent Brigham Hospital at present.

Take, for example, one condition which was presented by Dr. Miller, isolated pulmonic stenosis. That is a very difficult thing to diagnose by any ordinary means. It has been thought to be a very rare condition in the group of congenital heart diseases. Actually, we are finding more than the predicted percentage in our series of cardiac catheter studies. We find that it is difficult to either prove or disprove isolated pulmonic stenosis from angiocardiography. Frequently, the stenosis is covered up by the dilatation of the right ventricle or by the overlapping right auricle or even the superior vena cava in the oblique as well as the postero-anterior views.

The only definite way of proving pulmonary stenosis is either at autopsy when it is too late, or by the cardiac catheter when a very definite drop in pressure occurs as the catheter passes from the right ventricle into the pulmonary artery. We have recently seen 12 cases of isolated plumonic stenosis so confirmed, and a paper on our findings is now in press.

The point is this—that in 10 of the 12 cases, not invariably, as Dr. Miller's cases showed, there was definite post-stenotic dilatation of the pulmonary artery and even more striking to me and somewhat incomprehensive was an increased pulsation of the dilated pulmonary artery beyond the stenosis, exactly the reverse of what we would expect from our physiological knowledge of the circulation. Now when we see a dilated and pulsating pulmonary artery, we do not exclude pulmonic stenosis because of that increased pulsation.

The one thing we have learned from our studies, referring back to the regular routine films and fluoroscopies, is that the only one of the group which has dilatation of the main pulmonary artery with fairly normal hilar branches to the lung beyond that point is uncomplicated pulmonic stenosis. Now when we see a localized dilatation of a pulmonary artery with normal hilar branches just beyond it, we suspect at once that it is isolated pulmonic stenosis. Things like that, I think, are going to be the major dividends from this type of work.

All of us in general work would be wise to remember that we cannot make diagnoses from the roentgen ray alone in most of the cases of congenital heart disease, so that when we see an abnormal pulmonary artery we should find out, first, whether or not the patient has a murmur and, second, if there are any cardiac symptoms. In the absence of any cardiac symptoms and particularly in the absence of a murmur, I am inclined, and I think rightly, to disregard even a fairly marked dilatation of the pulmonary segment.

LUNG CANCER OPERABILITY*†

ANGIOCARDIOGRAPHIC STUDY OF FIFTY-THREE CONSECUTIVE PROVED CASES OF LUNG CANCER

By CHARLES T. DOTTER, M.D., ISRAEL STEINBERG, M.D., *and* CRANSTON W. HOLMAN, M.D.

NEW YORK, NEW YORK

INASMUCH as virtually the only prospect for cure in primary cancer of the lung resides in complete surgical extirpation of the lesion, the diagnosis of inoperability bears a grave responsibility and must be arrived at with extreme caution. Any doubt concerning the reliability of evidence pointing toward inoperability should be considered an indication for exploratory thoracotomy, now proved to be a safe and satisfactory method for establishing with certainty the nature and extent of pulmonary neoplasms.

The importance of angiocardiographic study in primary and metastatic cancer of the lung was first discussed by Steinberg and Robb[5] in 1938, and its value has been emphasized repeatedly during the ensuing eleven years.[1,3,4,6,7]

This report is based upon the findings in 53 consecutive cases of microscopically proved primary lung cancer which were studied angiocardiographically. Table 1 presents a summary of the angiocardiographic, operative and pathologic findings in these cases. It was found at the outset of the study that prognostic as well as diagnostic information could often be gained by the study of opacified mediastinal and pulmonary blood vessels.

DIAGNOSIS

As has been recently stressed,[1,3,7] angiocardiography may serve in the differential diagnosis of pulmonary masses. Any space-occupying lung lesion may, by virtue of external pressure, cause luminal narrowing and occasionally actual obstruction of mediastinal vessels. We have repeatedly encountered superior vena caval block caused by retrosternal thyroid enlargement, have observed complete obstruction of branches of the pulmonary artery due to pressure from tuberculous nodes and Boeck's sarcoid (proved at operation), and have seen pulmonary vascular distortion apparently due to silicosis. Thrombosis or embolization of pulmonary arteries may simulate neoplastic occlusion. By conventional roentgenographic methods it is occasionally difficult to distinguish between the parenchymal shadows produced by infiltrative processes or poorly defined masses and those produced by atelectasis. Angiocardiography, by demonstrating a crowding together and displacement of segmental pulmonary arteries, may establish the diagnosis of atelectasis. In general, circumscribed tumors tend to spread or dislocate vessels rather than occlude them, whereas the invasive nature of cancer of the lung and other malignant tumors causes irregular alterations in the contour of vascular lumina, frequently producing complete stenosis of major pulmonary arteries. With experience it becomes possible to distinguish in most cases between vascular distortion due to circumscribed masses and the effects of malignant, infiltrative processes. The distinction may be likened to that encountered in the interpretation of gastrointestinal roentgenograms. Here, as in the contrast study of the vascular system, external pressure defects and actual infiltrative lesions generally produce roentgenographically distinctive manifestations. Neuhof, Sussman and Nabatoff[3] have called attention to the fact that circumscribed

* From the Departments of Radiology, Medicine and Surgery of the New York Hospital-Cornell Medical Center. Presented at the Fiftieth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Oct. 4–7, 1949.

† This investigation was aided by grants from the Oren Root Estate and the Schering Corporation.

TABLE I

Case Number	Age, Sex, Unit Number	Angiocardiographic Findings	Angiocardiographic Diagnosis	Angiocardiographic Prognosis	Operation	Proof of Tumor	Remarks
1	54 ♂ NYH-314521	Large L.U.L. mass surrounding, distorting and partially occluding L.P.A. at hilus	Cancer of lung	Inoperable	Explored, inoperable. ("frozen hilus")	Biopsy and postmortem—cancer of lung	ACG clearly showed involvement of L.P.A. at hilus, shown at autopsy to be within pericardial sheath
2	56 ♀ NYH-530767	Mass at right apex with total block of right subclavian vein	Cancer of lung	Inoperable	Explored, inoperable. (pleural spread)	Biopsy showed bronchogenic cancer	AGG showed extension of lesion out of lung and into chest wall. Bronchoscopy had been negative
3	48 ♂ NYH-533471	Normal chest and cardiovascular structures	Inconclusive (normal)	Not demonstrably inoperable	Right pneumonectomy	Operative specimen and bronchoscopy showed cancer of R.M.B.	ACG of no diagnostic or prognostic value
4	67 ♂ NYH-514358	Distortion of L.P.A. at hilus by large mass related to left heart border	Cancer of lung	Inoperable	Not offered (Inoperable on bronchoscopy)	Bronchoscopic visualization, sputum cytology	ACG offered collateral proof of inoperability by indicating the presence of a "frozen hilus"
5	52 ♂ NYH-529848	S.V.C. stenosed and shown to lie within a density in the right superior mediastinum or R.U.L.	Tumor (mediastinal)	Inoperable	Not offered (cervical node metastasis)	Biopsy of metastatic node in neck—oat cell cancer of lung	ACG showed collateral proof of inoperability; failed to distinguish between pulmonary and mediastinal tumor
6	59 ♂ NYH-519268	R.U.L. peripheral tumor with pressure defects present in R.P.A. outlined by contrasted vessels	Cancer of lung	Inoperable	Not offered (believed inoperable)	Aspiration biopsy—epidermoid cancer of bronchus	ACG demonstrated vascular filling defects in mediastinum caused by mediastinal node extension
7	50 ♂ NYH-526450	Marked irregular narrowing and distortion of L.P.A. at hilus. Avascularity of left lung	Cancer of lung	Inoperable	Explored, inoperable ("frozen hilus")	Bronchoscopic biopsy—cancer of lung	ACG demonstrated central involvement of L.P.A.
8	40 ♂ NYH-462644	Large mass in left mid-lung field, close to hilus. No demonstration of vascular involvement	Tumor (lung or mediastinum)	Not demonstrably inoperable	Not offered (rapid downhill course)	Autopsy—large anaplastic cancer of lung without vascular involvement but mediastinal metastases	ACG of no significant prognostic value since there was no vascular involvement
9	49 ♂ NYH-521976	L.U.L. infiltration adjacent to mediastinum with marked elevation and distortion of L.P.A.	Cancer of lung	Inoperable	Explored, inoperable (mediastinal spread)	Biopsy at operation—cancer of lung	By showing vascular distortion and stenosis, ACG pointed toward tumor as against infection and placed the lesion at hilus and mediastinum
10	60 ♂ NYH-530146	R.U.L. mass, poorly defined, causing distortion of superior branch of R.P.A. but not typical of neoplastic obstruction	Inconclusive (tumor or infection)	Not demonstrably inoperable	Not offered (metastatic cervical node present)	Biopsy of cervical lymph-node—cancer of lung	ACG findings inconclusive
11	58 ♂ NYH-505720	Peripheral round discrete R.L.L. tumor producing no significant vascular abnormality	Tumor (primary or metastatic)	Not demonstrably inoperable	R.L.L. lobectomy	Operative specimen—localized oat cell carcinoma	Vascular pattern in region of tumor was unremarkable (subsequent recurrence and death)

Case, Number	Age, Sex Unit Number	Angiocardiographic Findings	Angiocardiographic Diagnosis	Angiocardiographic Prognoss	Operation	Proof of Tumor	Remarks
12	46 ♂ NYH-489776	R.U.L. infiltration with widening of superior mediastinum. Marked obstruction of S.V.C.	Cancer of lung	Inoperable	Not offered (tracheal invasion on bronchoscopy)	Biopsy, autopsy—oat cell carcinoma	ACG showed complete stenosis of S.V.C. caused by mediastinal invasion, collateral proof of inoperability
13	56 ♂ NYH-516428	Infiltration, L.U.L. No vascular or mediastinal involvement	Inconclusive (tumor or infection)	Not demonstrably inoperable	Explored, inoperable (palliative left pneumonectomy)	Operative specimen—infiltration of cut end of bronchus, cancer of lung	ACG failed to demonstrate mediastinal spread which was present
14	65 ♂ NYH- 75709	L.U.L. mass, surrounding, constricting L.P.A. 1.5 cm. distal to its origin	Cancer of lung	Probably inoperable	Left pneumonectomy	Operative specimen—anaplastic cancer of bronchus, involvement hilar lymph nodes	Tumor resected but there was microscopic evidence of spread to hilus as suggested by ACG. (Recurrence occurred later.)
15	55 ♂ NYH-513604	Mass in L.U.L. posteriorly causing upward retraction of L.P.A. but not causing stenosis	Cancer of lung	Not demonstrably inoperable	Explored, inoperable (palliative left pneumonectomy)	Operative specimen—cancer of lung, invasion bronchial nodes	ACG by demonstration of retraction of L.P.A. ruled out suspected benign neurogenic tumor
16	47 ♀ NYH-499110	Atelectasis R.M.L., deformity of inferior right pulmonary vein, marked thickening of pericardium over right atrium	Cancer of lung	Inoperable	Refused operation	Bronchoscopic biopsy—cancer of bronchus	By demonstrating a localized infiltration of the pericardium ACG established inoperability
17	46 ♂ NYH-522648	Atelectasis of right lung, obliteration of R.P.A., polypoid filling defect in S.V.C. shown in two projections	Cancer of lung	Inoperable	Not offered (tracheal invasion) on bronchoscopy)	Bronchoscopic biopsy—carina involved by epidermoid cancer of bronchus	Filling defect in S.V.C. thought to represent actual mass of tumor tissue growing within vessel
18	61 ♂ NYH-512868	Large round tumor mass L.U.L., complete occlusion of L.P.A. at its origin	Cancer of lung	Inoperable	Explored, inoperable ("frozen hilus")	Autopsy—epidermoid carcinoma of bronchus	Inoperability evidenced by ACG demonstration of irregular, complete stenosis of L.P.A. at its origin
19	50 ♂ NYH-511824	Mass, apical segment L.L.L., definite narrowing of descending branch of L.P.A. as it passed through mass	Cancer of lung	Not demonstrably inoperable	Left pneumonectomy	Operative specimen—pleomorphic cancer of lung without evidence of spread	Vascular stenosis at a distance from hilus suggests malignant tumor but not inoperability (Recurrence and death, 1 year)
20	46 ♂ NYH-525971	Infiltrative process left hilus with irregular complete stenosis of L.P.A. at its origin	Cancer of lung	Inoperable	Explored, inoperable (L.P.A. could not be found)	Operative biopsy—epidermoid cancer of bronchus	ACG showed extensive infiltration of hilus and thus inoperability
21	49 ♂ NYH-505315	Mass in middle of left lung, hilar and mediastinal nodes causing pressure defects and stenosis of L.P.A. and pulmonary veins	Cancer of lung	Inoperable	Explored, inoperable ("frozen hilus")	Operative biopsy—pleo-morphic cancer of lung	ACG showed direct hilar and mediastinal extension and therefore inoperability
22	51 ♂ NYH-523134	Large L.L.L. mass with downward retraction of L.P.A.	Cancer of lung	Not demonstrably inoperable	Left pneumonectomy (Block dissection of involved pericardium)	Operative specimen—cancer of lung, extension to pericardium	No additional information of diagnostic or prognostic nature

Case, Number	Age, Sex Unit Number	Angiocardiographic Findings	Angiocardiographic Diagnosis	Angiocardiographic Prognosis	Operation	Proof of Tumor	Remarks
23	61 ♂ NYH-498312	L.L.L. infiltration and local avascularity, but no hilar vascular changes	Cancer of lung	Not demonstrably inoperable	Left pneumonectomy (removal of part of diaphragm and chest wall)	Operative specimen—undifferentiated "bronchogenic" cancer	ACG of little value. Diagnosis had already been established bronchoscopically and could not have been made angiocardiographically
24	70 ♂ NYH-529297	Irregularly widened superior mediastinum with total block of S.V.C.	Tumor (mediastinal)	Inoperable	Not offered (S.V.C. block)	Autopsy—small cancer of lung, extensive mediastinal metastases	ACG demonstrated diffuse mediastinal involvement by a malignant tumor
25	74 ♂ NYH-514763	R.M.L. mass with pleural thickening lateral to mass. R.P.A. displaced posteriorly but not narrowed or occluded	Cancer of lung	Not demonstrably inoperable	Not offered (pleural spread)	Cytological examination of pleural fluid repeatedly strongly positive	ACG failed to contribute significantly to diagnosis or prognosis
26	46 ♂ NYH-522611	Infiltration, posterior apical segment of R.U.L. Upward retraction of superior branch of R.P.A.	Inconclusive (probable cancer of lung)	Not demonstrably inoperable	Right pneumonectomy	Operative specimen—cancer of lung without demonstrable extension	ACG by showing retraction of superior branch of R.P.A. eliminated benign tumor from differential diagnosis. Chronic infection could cause similar findings
27	70 ♂ NYH-310302	Infiltration and atelectasis in L.U.L. distortion but not stenosis of L.P.A. was present	Cancer of lung	Probably inoperable	Left pneumonectomy	Operative specimen—cancer of lung without evidence of vascular or hilar involvement	ACG interpretation in error. In retrospect there was insufficient evidence for the diagnosis of "probably inoperable"
28	60 ♂ NYH-498684	Infiltration and partial atelectasis of L.U.L. No demonstration of L.P.A. involvement. Poor films	Cancer of lung	Not demonstrably inoperable	Explored inoperable (large mass fixed to mediastinum)	Biopsy of mediastinal node—primary cancer of bronchus	Impossible to demonstrate the features of inoperability because of poor films and lack of vascular involvement
29	57 ♂ NYH-506653	Discrete ovoid density in right hilus causing extrinsic pressure defects in right hilar vessels	Tumor (right hilus)	Not demonstrably inoperable	Not offered (bronchoscopic evidence of inoperable cancer of right bronchus)	Bronchoscopic biopsy—cancer of bronchus	ACG findings compatible with either benign or malignant tumor or an enlarged non-neoplastic lymph node
30	51 ♂ NYH-538206	R.U.L. infiltrative process. No vascular involvement	Inconclusive (tumor or infection)	Not demonstrably inoperable	Right pneumonectomy	Operative specimen—cancer of bronchus, no evidence of hilar extension	ACG of no positive diagnostic or prognostic value
31	54 ♂ NYH-538475	R.U.L. mass and mediastinal widening, complete stenosis of right subclavian vein	Cancer of lung	Inoperable	Not offered (S.V.C. block)	Bronchoscopic biopsy—epidermoid cancer of bronchus	ACG showed definite mediastinal extension and stenosis of right subclavian vein
32	59 ♂ NYH-534471	R.U.L. infiltration, distortion of superior vena cava and two extrinsic pressure defects in S.V.C.	Cancer of lung	Inoperable	Not offered (S.V.C. block)	Autopsy—cancer of lung with mediastinal extension	ACG demonstration of inoperability through vascular evidence of mediastinal extension
33	60 ♂ NYH-538340	L.U.L. mass, destruction of left 2nd rib, mediastinal mass with irregular stenosis of L.P.A. at origin	Cancer of lung	Inoperable	Not offered (Bone metastasis)	Biopsy axillary node—cancer of lung	Collateral and convincing angiocardiographic evidence of inoperability

Case, Number	Age, Sex Unit Number	Angiocardiographic Findings	Angiocardiographic Diagnosis	Angiocardiographic Prognosis	Operation	Proof of Tumor	Remarks
34	31 ♂ BH-156822	Massive atelectasis of left lung with herniation of right lung into left chest. L.P.A. not seen. No demonstration of tumor	Inconclusive (atelectasis)	Not demonstrably inoperable	Left pneumonectomy	Operative specimen—transitional cell cancer, invading along bronchus	No aid in diagnosis or prognosis. ACG confirmed presence of atelectasis
35	50 ♂ NYH-115751	Mass, L.U.L., related to left hilus, causing occlusion of L.P.A. at hilus	Cancer of lung	Inoperable	Explored, inoperable ("frozen hilus")	Operative biopsy—cancer of lung	ACG offered convincing evidence of inoperability
36	60 ♂ Submitted	R.U.L. atelectasis, pleural thickening and effusion. Avascularity of R.U.L. with retraction of S.V.C.	Inconclusive (tumor or infection)	Not demonstrably inoperable	Explored, inoperable (tumor fixed to mediastinum)	Operative biopsy—anaplastic cancer of lung	Despite its proximity to tumor, S.V.C. was not involved, showing the worthlessness of a favorable prognosis based on angiocardiographic findings
37	58 ♂ Submitted	L.U.L. mass with stenosis of L.P.A. A short distance distal to its origin	Cancer of lung	Probably inoperable	Not offered (cervical node metastasis)	Biopsy of cervical node—cancer of lung	ACG pointed toward pulmonary rather than mediastinal tumor
38	40 ♂ BH-66324	Upward retraction L.P.A. toward a L.U.L. mass. Avascularity of L.U.L. But no stenosis of L.P.A.	Cancer of lung	Not demonstrably inoperable	Not offered (metastasis to skull)	Autopsy—cancer L.U.L. with mediastinal spread	ACG appearance that of cancer though not demonstrably inoperable
39	48 ♂ NYH-541645	R.L.L. infiltration causing displacement of descending branch of R.P.A. But no stenosis	Cancer of lung	Not demonstrably inoperable	Explored, inoperable (hilar spread)	Operative biopsy—undifferentiated cancer of lung	ACG of no diagnostic or prognostic value. Changes could have resulted from tumor or infection
40	61 ♀ NYH-533391	R.L.L. atelectasis with diminished filling and crowding together of vessels. No occlusion or stenosis	Inconclusive (atelectasis)	Not demonstrably inoperable	Right pneumonectomy	Operative specimen—cancer bronchus with hilar node involvement	ACG indicated only that atelectasis was present. Not diagnostic or prognostic of tumor
41	63 ♂ NYH-539963	Left pleural effusion, no vascular deformity	Inconclusive (pleural effusion)	Not demonstrably inoperable	Explored inoperable (extensive pleural implantation)	Operative biopsy—anaplastic cancer of lung	ACG of no diagnostic or prognostic aid
42	63 ♂ NYH-539811	Infiltrating process in L.U.L. producing slight irregularity of distal L.P.A.	Inconclusive (tumor or infection)	Not demonstrably inoperable	Left pneumonectomy	Operative specimen—cancer of lung	ACG of no diagnostic or prognostic aid. Vascular deformity present but inconclusive
43	62 ♂ NYH-543943	R.L.L. infiltrations, irregular stenosis of R.P.A. and mediastinal pleural thickening were present	Cancer of lung	Inoperable	Not offered (mediastinal metastases)	Cytological study of sputum repeatedly and strongly positive	ACG materially aided in arriving at decision of inoperability along with collateral clinical and roentgen evidence
44	57 ♂ NYH-543917	Infiltration, left apex. Left pleural effusion. Diminution in size of L.P.A. But no definite stenosis	Inconclusive (tumor or infection)	Not demonstrably inoperable	Explored inoperable (extensive pleural spread)	Operative biopsy—anaplastic cancer of lung	Degree of vascular abnormality not considered diagnostic

Case, Number	Age, Sex Unit Number	Angiocardiographic Findings	Angiocardiographic Diagnosis	Angiocardiographic Prognosis	Operation	Proof of Tumor	Remarks
45	49 ♂ NYH-543948	Mass L.U.L., producing no vascular deformity	Inconclusive (tumor or infection)	Not demonstrably inoperable	Left pneumonectomy	Operative specimen—cancer of lung with abscess formation	ACG added nothing to diagnosis or prognosis
46	56 ♂ NYH-542859	Mass L.U.L. producing stenosis of L.P.A. 3.5 cm. from bifurcation	Cancer of lung	Not demonstrably inoperable	Left pneumonectomy	Operative specimen—cancer bronchus with abscesses	ACG of diagnostic but no prognostic aid
47	51 ♂ NYH-469654	Right pleural effusion, complete occlusion of inferior branch of R.P.A. at hilus	Cancer of lung	Inoperable	Refused operation	Bloody pleural effusion with cytological evidence of cancer of lung	ACG was first indication of nature and extent of lesion
48	69 ♂ NYH-549247	Large L.U.L. mass with avascularity but no demonstrable hilar occlusion of L.P.A. though narrowing at 6 cm. from bifurcation	Cancer of lung	Not demonstrably inoperable	Explored inoperable	Operative biopsy—cancer of lung	ACG showed vascular narrowing but did not establish inoperability
49	72 ♂ NYH-550428	Pulmonary arteries to R.L.L. crowded together as in atelectasis stenosis of peripheral vessels, R.L.L.	Atelectasis	Not demonstrably inoperable	Right pneumonectomy	Operative specimen—cancer of bronchus	ACG confirmed presence of atelectasis; failed to demonstrate cause
50	65 ♂ BYH-549642	Infiltration involving right hilus with obliteration of ascending branch of R.P.A.	Cancer of lung	Inoperable	Right pneumonectomy	Operative specimen—cancer of R.U.L., apparently successfully removed	ACG showed extent and effect of tumor. Inoperable prognosis unwarranted since tumor was not demonstrably out of the lung
51	50 ♂ NYH-551157	Mass causing stenosis, filling defect of S.V.C., stenosis of R.P.A. at its bifurcation	Cancer of lung	Inoperable	Not offered (metastasic cervical node present)	Biopsy of cervical lymph node—cancer of lung	ACG showed S.V.C. and R.P.A. invasion, collateral and decisive proof of inoperability
52	44 ♂ NYH-551805	Left apical mass causing slight upward retraction of apical-posterior segmental artery, L.U.L.	Cancer of lung	Not demonstrably inoperable	Explored inoperable (paliative left upper lobectomy)	Operative specimen—cancer of lung with pleural invasion	ACG of little value save in ruling out neurogenic tumor
53	71 ♂ NYH-551609	Large mass, right chest, causing displacement and narrowing of S.V.C.	Inconclusive	Not demonstrably inoperable	Not offered (believed inoperable)	Cytological examination of sputum showed oat cell carcinoma of lung	ACG (inferior technical quality) showed only the effects of extrinsic pressure on S.V.C.

R.P.A. —Right pulmonary artery
L.P.A. —Left pulmonary artery
S.V.C. —Superior vena cava
R.M.L.—Right middle lobe
R.L.L. —Right lower lobe
R.U.L. —Right upper lobe
L.U.L. —Left upper lobe
L.L.L. —Left lower lobe
R.M.B.—Right main bronchus
A.C.G. —Angiocardiography

peripheral tumors of the lung, either benign or malignant, usually displace the adjacent branches of the pulmonary artery while infiltrative lesions are seen to surround or "engulf" the vessels approaching them. It is to be re-emphasized, however, that a malignant tumor may produce dislocation rather than occlusion of blood vessels if it is circumscribed in nature.

lar shadows are essential to the angiocardiographic diagnosis of lung cancer. Conclusions regarding neoplastic occlusion of a vessel should not be based upon the appearance of its "end-on" shadow, but from a view selected to show the vessel from the side (Fig. 7). Thus while the frontal projection is the view of choice for the demonstration of the right pulmonary artery or

FIG. 1. Case 1. Male, aged fifty-four. Frontal angiocardiogram and tracing, right heart and pulmonary arteries opacified. Large left upper lobe mass has caused irregular stenosis (arrow) of the entire left pulmonary artery (*LPA*). *RA*, right atrium; *RV*, right ventricle; *PC*, pulmonary conus; *PA*, pulmonary artery. Thoracotomy revealed an inoperable lung cancer. See also Figure 2.

Both infiltrative neoplasms and chronic pulmonary infections produce angiocardiographic evidence of avascularity, real or apparent, in the involved areas of lung parenchyma as well as distortion of pulmonary vessels. *Stenosis or occlusion must not be confused with reduced filling of pulmonary vessels.* In order to make the diagnosis of occlusion of a pulmonary artery, sufficient contrast substance must be seen in the suspicious area to demonstrate clearly the actual pathologic alteration in vascular contour. Films of satisfactory technical quality showing sharply contrasted vascu-

its branches, the left anterior oblique projection is preferable for study of the left pulmonary artery. It has occasionally been impossible to arrive with certainty at an opinion as to the neoplastic or infectious nature of infiltrative processes on the basis of angiocardiographically demonstrated vascular changes. The above reservations notwithstanding, the angiocardiographic diagnosis of lung cancer may sometimes be made with as high a degree of certainty as the diagnosis of gastric carcinoma may be made by the inspection of roentgenograms of the barium-filled stomach.

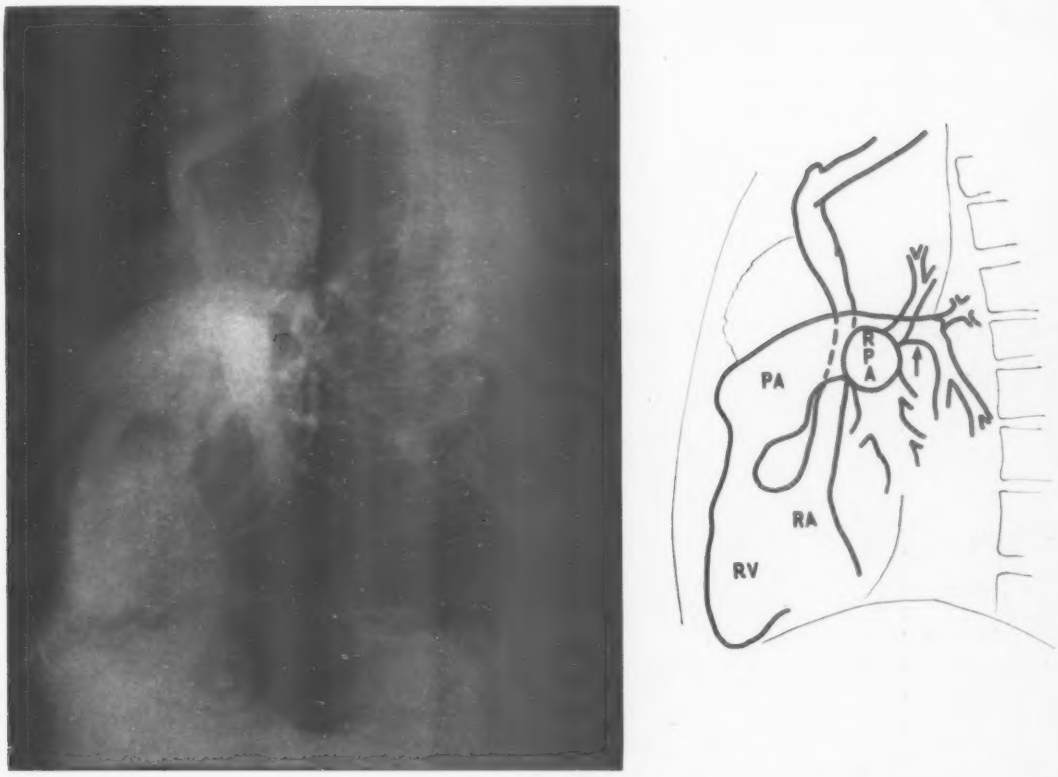

Fig. 2. Case 1. Male, aged fifty-four. Lateral angiocardiogram and tracing, right heart and pulmonary arteries opacified. The left upper lobe is atelectatic and largely replaced by tumor which has caused irregular stenosis of the left pulmonary artery at its point of origin (arrow). *RPA*, right pulmonary artery; *PA*, pulmonary artery; *RV*, right ventricle; *RA*, right atrium. Thoracotomy revealed an inoperable lung cancer. See also Figure 1.

In this series of 53 cases, an angiocardiographic diagnosis of cancer of the lung was made 34 times. (In 8 of these cases bronchoscopic or histopathologic proof of the lesion was available at the time of angiocardiographic interpretation.) A diagnosis of tumor, not specifically primary in the lung, was made in 4 additional cases, while the findings were considered diagnostically inconclusive in the remaining 15 instances. Even in this group where the findings were considered indecisive, angiocardiography, by suggesting a neoplastic rather than an infectious process, occasionally provided additional indication for exploratory surgery.

PROGNOSIS

An inoperable lung cancer may be defined as one which cannot be surgically removed without leaving grossly visible or palpable evidence of tumor behind.[2] Among frequently mentioned criteria of inoperability in lung cancer are phrenic and recurrent laryngeal nerve paralyses, Horner's syndrome, bloody or cytologically malignant pleural effusion, bronchoscopic evidence of involvement of the carina and the demonstration of distant metastases. Several of these criteria are open to question in the light of the more radical approach to malignancy which is generally employed today. It has been the surgical practice in this center to conduct radical dissection of the mediastinum, pericardium, chest wall or diaphragm when such procedure offered promise of complete removal of the neoplasm. Pneumonectomy with the implantation of radon seeds directly into involved unresectable mediastinal lymph nodes may prove to be a useful technique. It should, however, be pointed out that insufficient data have yet been accumulated to war-

rant undue enthusiasm in this respect. Obvious involvement of mediastinal nodes probably indicates the presence of grossly undetectable extension beyond the reach of the surgeon.

In order to study the value of angiocardiography in the prognostic evaluation of lung cancer, all of the cases of suspected tumor in this series were placed (prior to operation or without knowledge of operative findings) into three categories based upon angiocardiographic findings. These categories were: (1) not demonstrably inoperable, (2) probably inoperable, (3) inoperable. A prognosis was given in all cases where tumor, either pulmonary or mediastinal was considered a possibility. The three prognostic groups will be considered separately.

Inoperable. Of the 53 cases in this series, 22 were thought to present convincing angiocardiographic evidence of inoperability. Of these, 8 were explored and found to be inoperable. The remainder of the "angiocardiographically inoperable" group, comprising 14 cases, was not explored. Eight of these were shown to be inoperable by collateral means: 3 (Cases 5, 33 and 51) had peripheral metastases which were biopsied; 3 (Cases 4, 12 and 17) had bronchoscopic evidence of tracheal involvement; 2 (Cases 24 and 32) were shown at autopsy to have extensive direct and metastatic spread of neoplasm. Proof of inoperability was not obtained in 3 cases (Cases 6, 31 and 43) where operation was deemed inadvisable upon clinical grounds. One of these patients is known to have died within

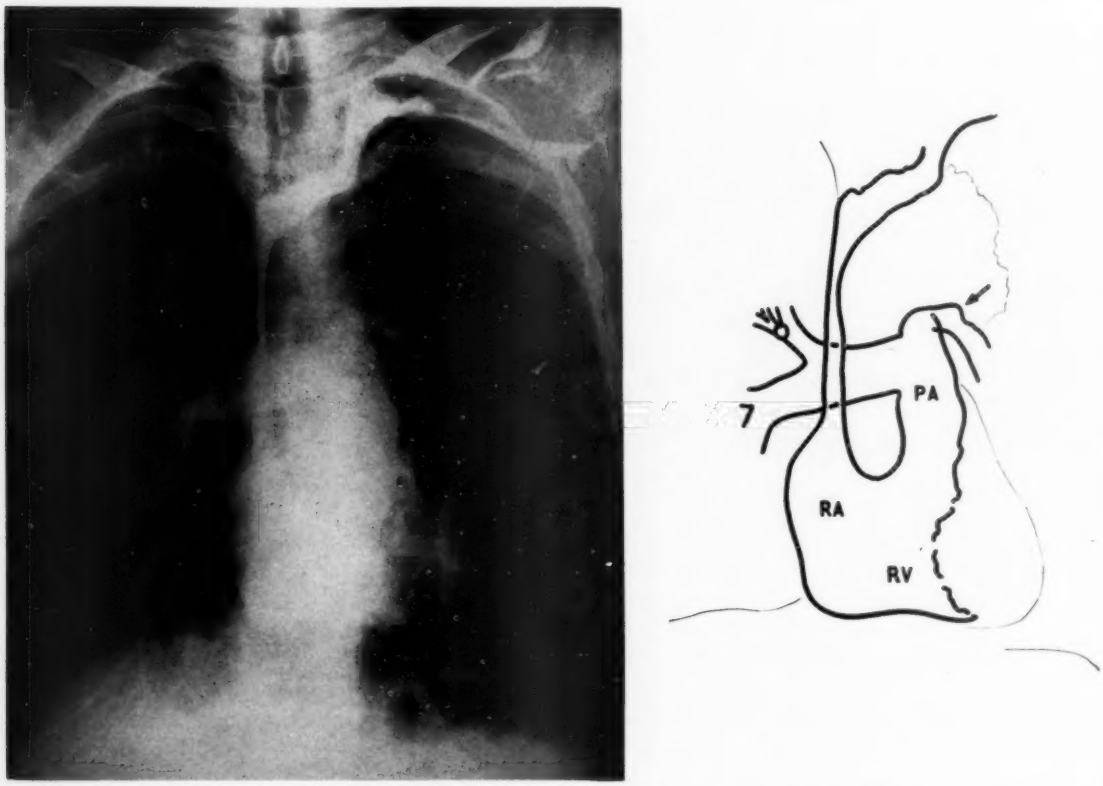

FIG. 3. Case 9. Male, aged forty-nine. Frontal angiocardiogram and tracing, right heart and pulmonary arteries opacified. A left upper lobe infiltrative process has blended with the mediastinum and caused upward elevation and stenosis of left pulmonary artery at hilum (arrow). *RA*, right atrium; *RV*, right ventricle; *PA*, pulmonary artery. Exploratory thoracotomy confirmed the angiocardiographic impression of inoperable cancer of the lung.

three months while the other 2 could not be followed. Two cases refused operation; while no follow-up could be obtained in 1 of these (Case 16), the other was thought to be inoperable because of the presence of malignant cells in pleural fluid. The remaining case (Case 50) proved to be operable (by our criteria) and right pneumonectomy was accomplished. Thus in 53 cases of proved cancer of the lung, a diagnosis of angiocardiographic evidence of inoperability was made 22 times. Anatomic substantiation of the diagnosis was obtained in 16 of the 22 cases, while in only 1 case (Case 50) was there found subsequent reason to challenge the prognosis. In several instances angiocardiography furnished the most convincing evidence of inoperability prior to operation or autopsy.

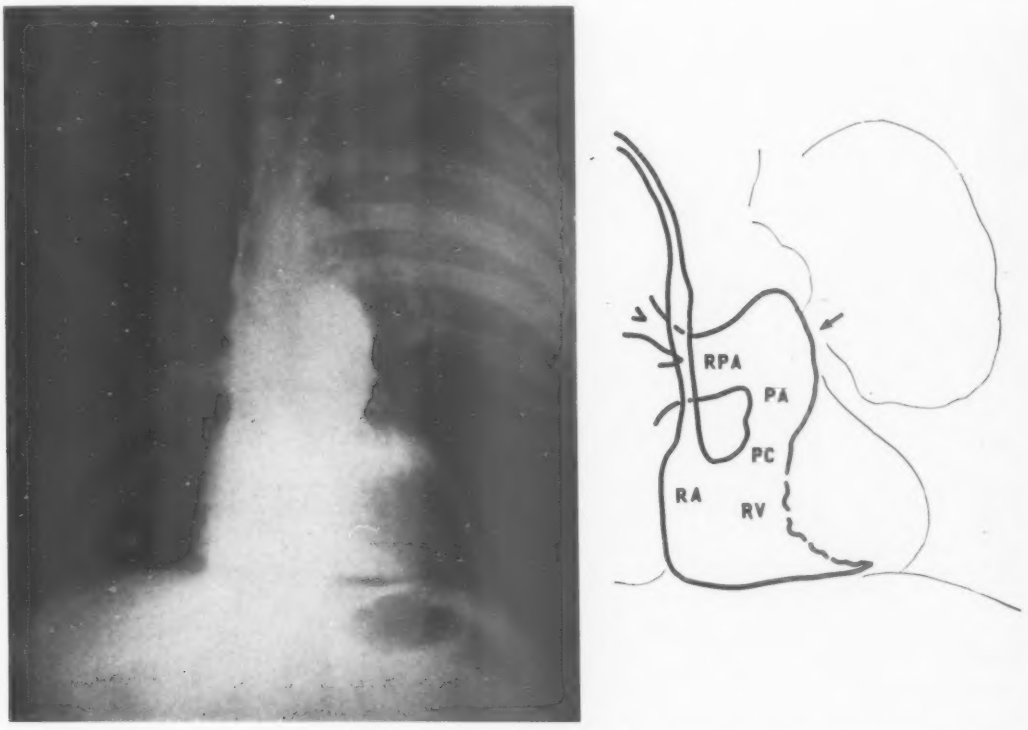

FIG. 4. Case 18. Male, aged sixty-one. Frontal angiocardiogram and tracing, right heart and pulmonary arteries opacified. A large left upper lobe mass has caused complete occlusion of left pulmonary artery (arrow). A mediastinal metatstasis is seen just above the pulmonary artery. *RPA*, right pulmonary artery; *PA*, pulmonary artery; *PC*, pulmonary conus; *RV*, right ventricle; *RA*, right atrium. Angiocardiographic impression of inoperable lung tumor confirmed surgically. See also Figure 5.

Probably Inoperable. The diagnosis of "probably inoperable" was made 3 times in this series of 53 cases. Resection was accomplished in 2 instances (Cases 14 and 27). Microscopic examination of the operative specimen in 1 of these cases (Case 14) indicated that extension to the mediastinum had probably occurred although this could not be detected at the time of operation. Another case (Case 27) failed to show angiocardiographically predicted hilar involvement. The third case (Case 37) was not offered surgery and died following a short course of radiation therapy. The lack of correlation between the angiocardiographic prognosis and the operative findings in this small group as compared to the group diagnosed as angiocardiographically "inoperable" serves to emphasize the generality that a diagnosis of inoperability should be made only in the presence of the most convincing evidence.

Not Demonstrably Inoperable. Of the 53

cases in this series, 28 were reported as showing no angiocardiographic evidence of inoperability. Exploratory thoractomy was performed 22 times. Twelve cases were subjected to pneumonectomy and in 2 of these cases (Case 34 and 40) there was microscopic evidence of extension to the mediastinum. Ten cases were explored and found to be inoperable; in 3 of these (Cases 13, 15 and 52) palliative pneumonectomy or lobectomy was carried out. The remaining 6 cases of this group were not explored, proof of inoperability consisting of biopsy of cervical node metastasis (Cases 10 and 38), microscopic demonstration of malignant cells in pleural fluid (Case 25), bronchoscopic evidence of tracheal involvement (Case 29), and, in a patient deemed too ill to explore, subsequent autopsy demonstration of extensive mediastinal involvement (Case 8). The remaining case (Case 53) was judged inoperable on clinical grounds and is receiving radiation therapy. Of 28 cases showing no angiocardiographic evidence of inoperability, 19 were proved to be inoperable. Thus it is seen that whereas the angiocardiographic demonstration of inoperability correlated very well with operative and pathologic findings, the lack of vascular changes could not be considered indicative of a favorable prognosis. This is not surprising since neoplastic invasion without vascular deformity may readily occur.

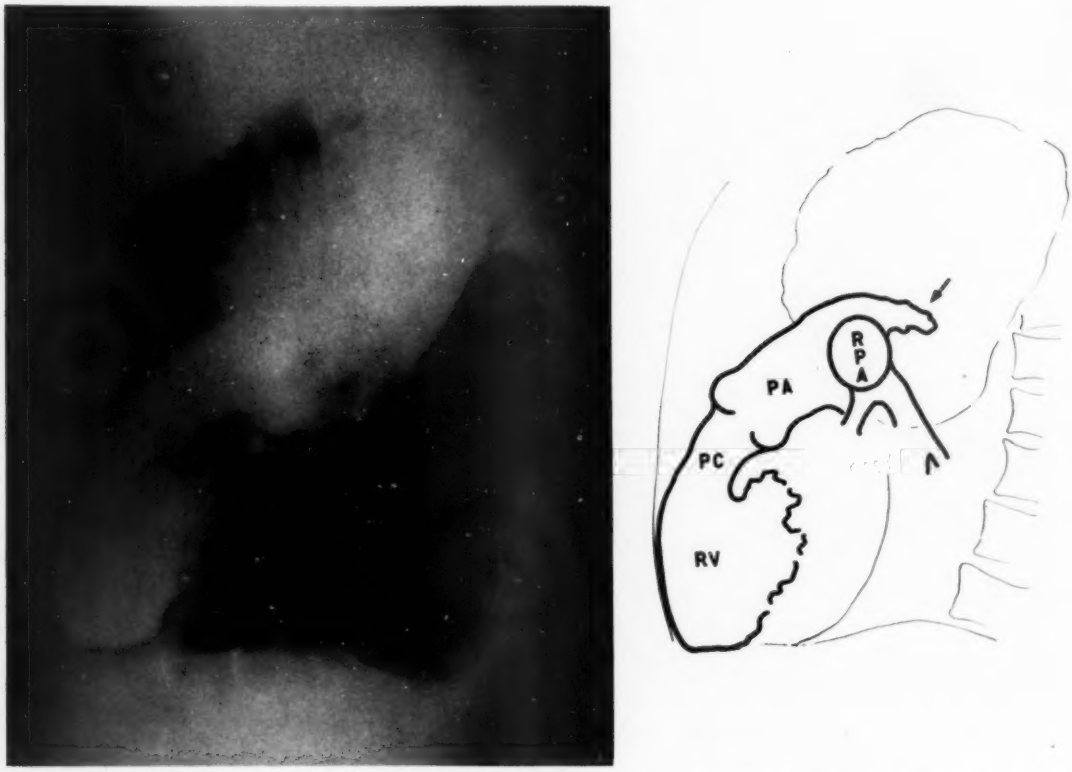

FIG. 5. Case 18. Male, aged sixty-one. Lateral angiocardiogram and tracing, right heart and pulmonary arteries opacified. Left upper lobe mass causes complete stenosis of left pulmonary artery (arrow). *RV*, right ventricle; *PC*, pulmonary conus; *PA*, pulmonary artery; *RPA*, right pulmonary artery. The anterior and posterior cusps of the pulmonic valve are shown. Angiocardiographic impression of inoperable lung tumor confirmed surgically. See also Figure 4.

Error in Diagnosis and Prognosis. In assembling the present series of cases, the diagnosis of cancer of the lung was made in error 3 times; once in the presence of pul-

monary actinomycosis, once in the differential diagnosis of an infiltrative lesion which proved to be tuberculous, and once in the presence of lymphosarcoma of pulmonary bronchial lymph nodes. Upon review of the first 2 of these 3 cases in the light of experience subsequently obtained, it is felt that the vascular changes did not warrant the diagnoses made. In the third case, an angiocardiographic diagnosis of inoperable carcinoma of the lung was made. At operation, a mass was felt in the lung which was removed as were several moderately enlarged mediastinal nodes. Microscopic examination revealed the tumor and the mediastinal nodes to be lymphosarcomatous. A review of the angiocardiograms failed to show any point of distinction between the findings and those produced by primary cancer of the lung.

Prognostic error was present in 3 cases of this series (Cases 14, 27 and 50) which were diagnosed as "probably inoperable" or "inoperable" and where pneumonectomy was accomplished without leaving gross evidence of tumor behind. In 1 of these cases (Case 50) angiocardiography showed a complete occlusion of the ascending branch of the right pulmonary artery at its point of origin and it was reasoned that the hilar presence of tumor was incompatible with operability. Although tumor was found in the hilus at the predicted site, it was possible to divide the right pulmonary artery proximal to this point. A diagnosis of inoperability should not be made in such instances unless the right pulmonary artery is involved proximal to its bifurcation. An error in prognosis was made in connection with the report on the case of

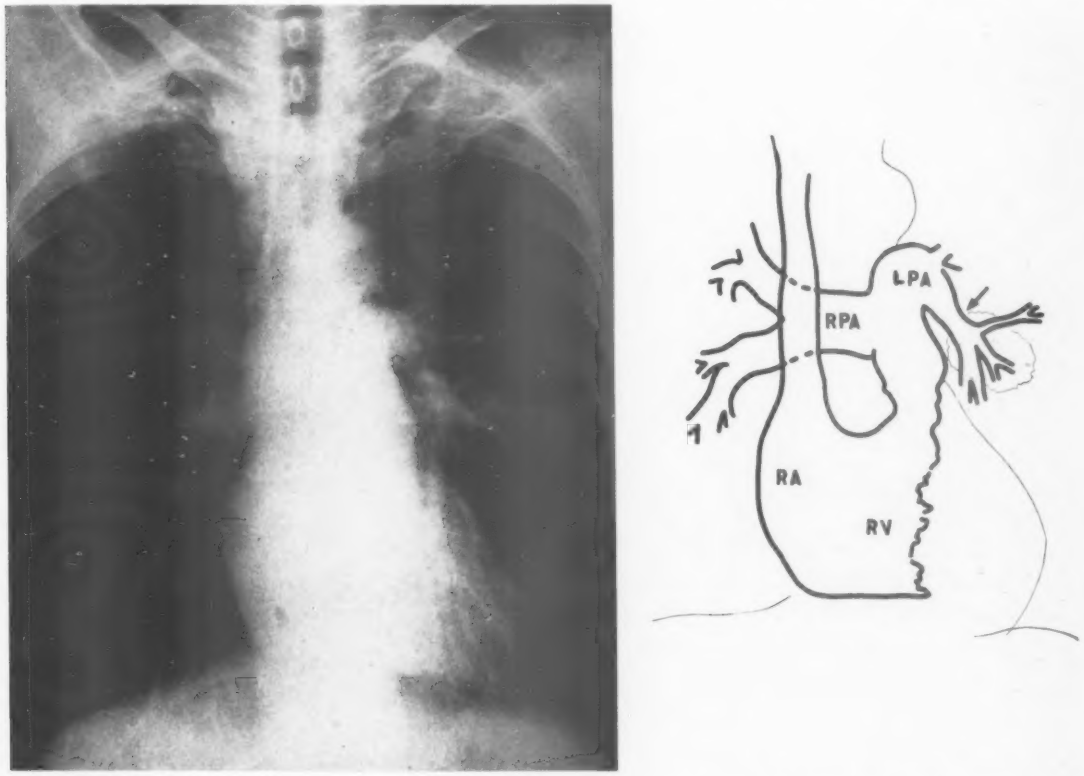

Fig. 6. Case 19. Male, aged fifty. Frontal angiocardiogram and tracing, right heart and pulmonary arteries opacified. There is a left lower lobe infiltration with definite narrowing of the descending left pulmonary artery (arrow). *RA*, right atrium; *RV*, right ventricle; *LPA*, left pulmonary artery; *RPA*, right pulmonary artery. Angiocardiographic impression, "carcinoma of left lower lobe, not demonstrably inoperable," was confirmed at left pneumonectomy. See also Figure 7.

pulmonary actinomycosis cited above. Such errors can be minimized by predicating the angiocardiographic prognosis upon the existence of tumor as illustrated in the following excerpt of the dictated report on Case 32: "Should the right upper lobe infiltration actually represent neoplasm, it is angiocardiographically inoperable." It is well to remember that pulmonary infections may produce vascular changes similar to those indicating inoperablity in the presence of primary cancer of the lung.

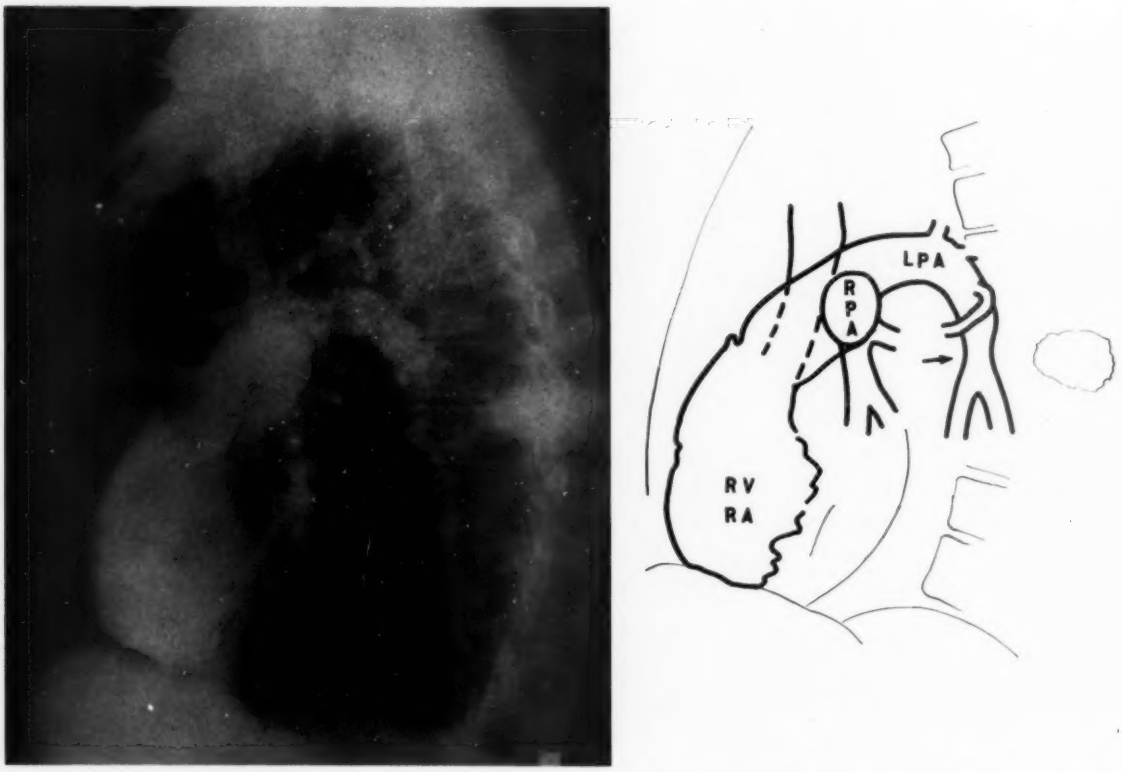

FIG. 7. Case 19. Male, aged fifty. Lateral angiocardiogram and tracing, right heart and pulmonary arteries opacified. There is narrowing (arrow) of the descending branch of the left pulmonary artery as it passes between left lower lobe infiltration and lung root. *RV*, right ventricle; *RA*, right atrium; *RPA*, right pulmonary artery; *LPA*, left pulmonary artery. Angiocardiographic impression, "carcinoma of left lower lobe, not demonstrably inoperable," was confirmed at left pneumonectomy. See also Figure 6.

ANGIOCARDIOGRAPHIC CRITERIA OF INOPERABILITY

As a result of this study of 53 consecutive proved cases of lung cancer, certain angiocardiographic findings in the presence of carcinoma of the lung are considered to be evidence of inoperability. In the order of the frequency of their occurrence in this series, these are:

(1) Partial or complete occlusion by tumor of the left pulmonary artery within 1.5 cm. of its site of origin (Figs. 1–7). Partial or complete occlusion by tumor of the right pulmonary artery proximal to its point of bifurcation (Fig. 8).

(2) Partial or complete occlusion of the great mediastinal veins due to tumor in the mediastinum (Fig. 9). Polypoid defects in the superior vena cava indicating the intraluminal growth of neoplasm have been observed.

(3) The demonstration of mediastinal metastases by the contrast delineation of displacement and deformity of adjacent vascular structures. This consists simply of the demonstration of masses within the mediastinum through external pressure defects on vessels. The vascular changes in themselves

are not diagnostic of malignant tumor tissue, but if the assumption is allowed that such masses are actually composed of the same tissue as a known peripheral cancer of the lung, it follows that mediastinal spread has occurred (Fig. 8).

(4) The demonstration of pericardial invasion by tumor. This consists of the demonstration of localized thickening of the pericardium in the absence of pleural disease in the vicinity. It was encountered in one case of this series (Case 16) (Fig. 10).

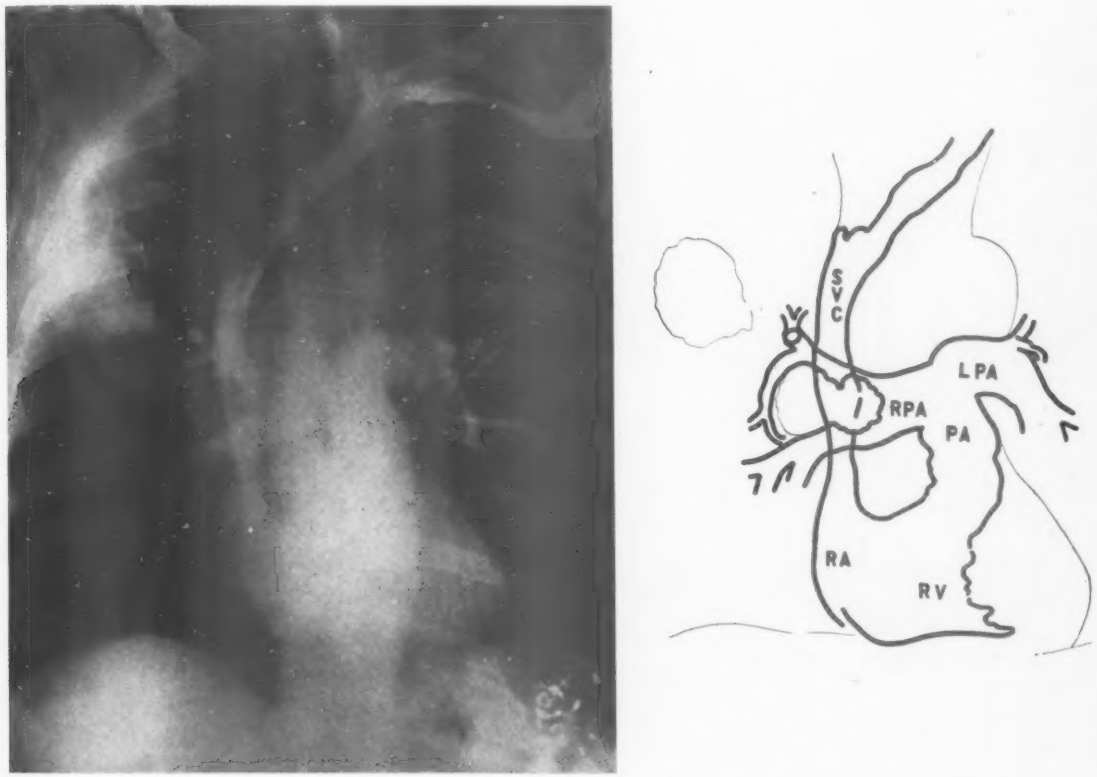

Fig. 8. Case 6. Male, aged fifty-nine. Frontal angiocardiogram and tracing, right heart and pulmonary arteries opacified. A right upper lobe mass is present as are filling defects in superior vena cava and right pulmonary artery caused by mediastinal metastases. *SVC*, superior vena cava; *RA*, right atrium; *RV*, right ventricle; *PA*, pulmonary artery; *LPA*, left pulmonary artery; *RPA*, right pulmonary artery. Aspiration biopsy established presence of carcinoma of lung which was considered inoperable.

Non-neoplastic conditions may cause or simulate any of the above changes and it is to be re-emphasized that the prognosis in any suspected case is predicated upon the assumption that tumor has been responsible for the observed changes. This being the case, it is apparent that in the light of present knowledge *no patient should be denied exploratory surgery on the basis of angiocardiographic changes alone.* As in any field of diagnostic medicine, all available means of diagnosis should be employed in arriving at a prognosis and plan of attack. It is likely that angiocardiographic study will in a number of cases assist the surgeon in determining whether or not operation is indicated, but it should serve only as additive or collateral evidence in the total assessment. Aside from its purely diagnostic and prognostic value, angiocardiography is of value to the thoracic surgeon in that it often indicates as no other preoperative examination can, the anatomical extent of the lesion, enabling him to plan the most suitable method of approach and informing him as to the otherwise hidden structures behind the tumor he plans to attack.[6] In

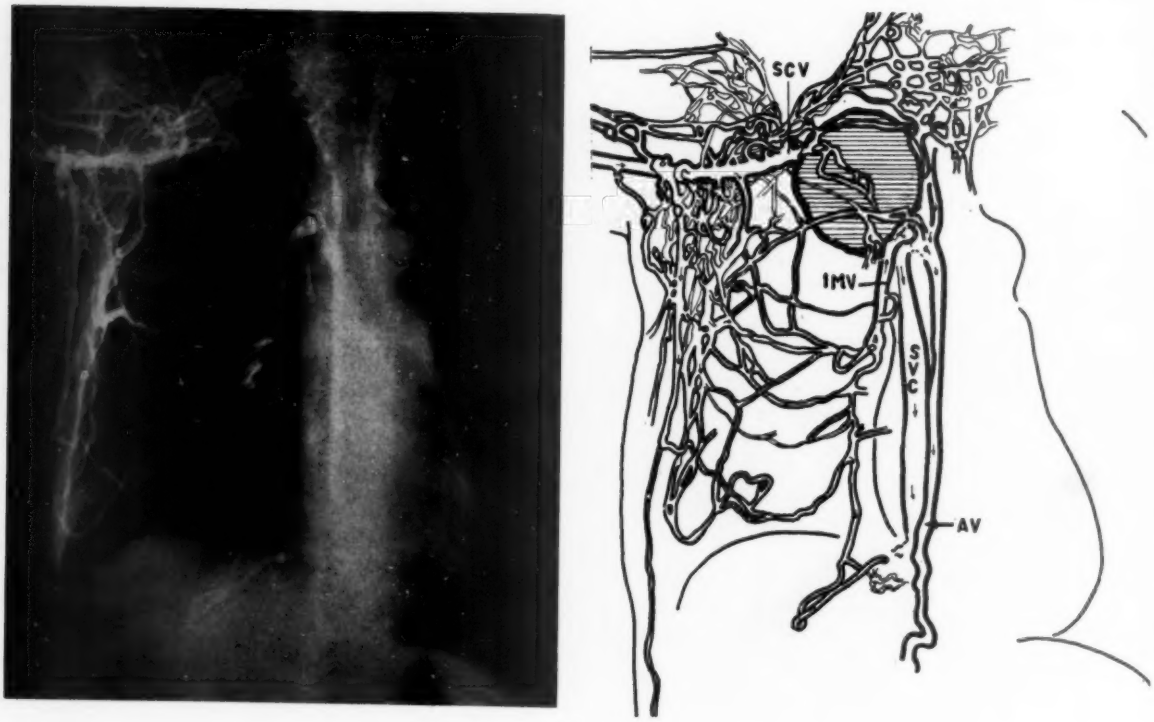

FIG. 9

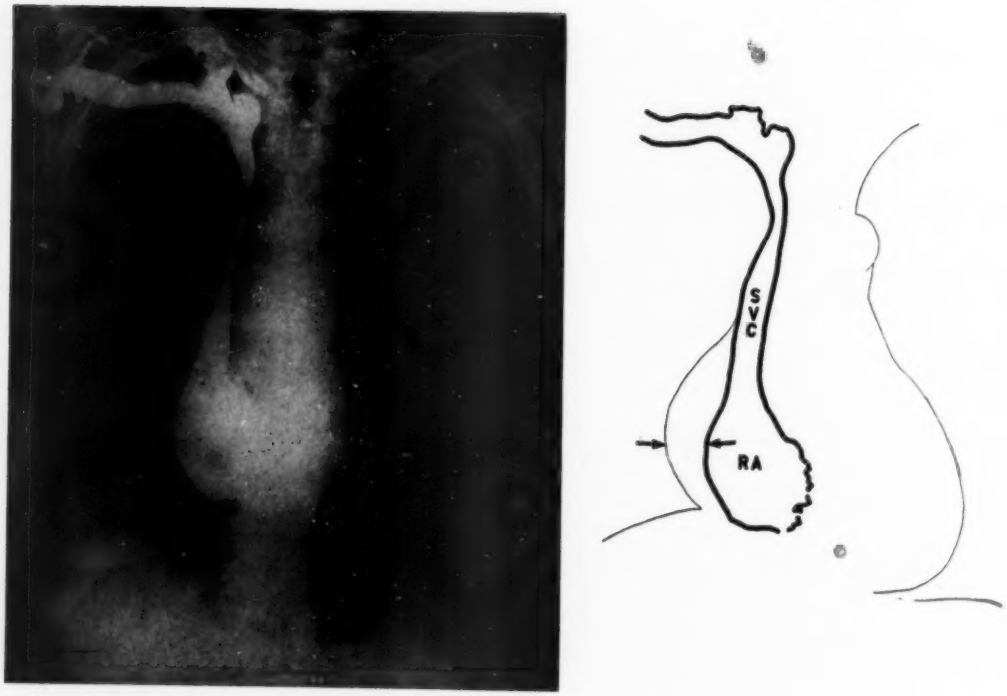

FIG. 10

Fig. 9. Case 2. Female, aged fifty-six. Frontal angiocardiogram and tracing (three seconds after injection). There is complete occlusion of right subclavian vein (*SVC*) outside of lung adjacent to right apical mass (horizontal shading). Extensive collateral veins are seen. *IMV*, right internal mammary vein; *AV*, azygos vein; *SVC*, superior vena cava. Angiocardiographic diagnosis of inoperable lung cancer confirmed at exploratory thoracotomy.

this manner, protracted exploration at the time of thoracotomy may often be avoided, thus lowering operative time and consequently the mortality. Further experience will serve to define and indicate more clearly the usefulness of angiocardiography in the study of cancer of the lung. In our hands, it has proved itself to be a most productive method of investigation, and it is routinely employed in the preoperative study of all cases of cancer of the lung.

SUMMARY

In a study of fifty-three proved cases of carcinoma of the lung, angiocardiography was found to be a valuable and unique source of diagnostic and prognostic information. The effects of malignant tumors upon vascular structures are often characteristic and afford otherwise unobtainable preoperative information as to the extent of neoplastic involvement. Although, at present, exploration of the patient with possible cancer of the lung should not be withheld on the basis of unsupported angiocardiographic findings, such information is of value in the planning and conduct of operation. The angiocardiographic signs of inoperability have in common the demonstration of neoplastic involvement of vascular structures beyond the limit of surgical resectability.

525 East 68th St.
New York 21, N. Y.

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DISCUSSION

Dr. L. R. Sante, St. Louis, Mo. The diagnosis of malignant tumors of the lung from correlation of the ordinary roentgen examination with the clinical history has reached a much higher plane within the past few years. In reviewing the clinical histories of patients in whom cancer of the lung was demonstrated at autopsy, it was found that the following criteria of symptoms and roentgen findings could be relied upon for a correct diagnosis of the disease in a surprisingly large percentage of instances.

If roentgen examination showed consolidation of any kind in the chest: in a patient who was forty years of age or over; with symptoms which have persisted for three months or longer; without fever or other indication of infection; with progressive loss of weight without other demonstrable cause; with possibly a slight cough of a dry or non-productive nature; and bloody sputum at some time during the illness, the condition could be considered as very probably of malignant origin.

Fig. 10. Case 16. Female, aged forty-seven. Frontal angiocardiogram and tracing, superior vena cava and right atrium opacified. The wide interval between neo-iopax in right atrium and right lung field (between arrows) is thought to represent invasion of the pericardium by a bronchoscopically demonstrated carcinoma of the right middle lobe bronchus. *SVC*, superior vena cava; *RA*, right atrium. Patient refused operation.

Such diagnostic methods are, of course, only presumptive—one might even say in certain instances, speculative. Coupled with many other confirmatory examinations, such as cytologic examination, bronchoscopic and bronchographic examination, needle biopsy, etc., the diagnosis may be established in a fairly large number of instances.

By and large it may be said, therefore, that through use of these agencies, the diagnosis of cancer of the lung has improved greatly in recent years.

But the mere establishment of the diagnosis is not enough; the all important question then becomes, is the tumor operable or inoperable? It is fitting and very timely, therefore, that angiocardiography should be developed to a point where it can become universally used as a diagnostic method for this purpose. It is not a formidable procedure; it does not require expensive accessory apparatus, especially where filling of the lung circulation alone is desired; and it can easily be performed in any well-equipped radiological department. The injection being intravenous is not painful and therefore does not require anesthesia in adults. The radiopaque medium, used for this purpose, has been so purified and concentrated that the danger from this source has been minimized.

The diagnostic criteria set forth by the authors in this presentation represents the dictates of good judgment. It would seem only natural that well defined circumscribed tumors would tend to spread or dislocate vessels rather than to invade or occlude them. On the other hand, invasive malignant tumors might be expected to invade vascular structures and engulf or occlude them. Well defined tumors, however, irrespective of their benign or malignant nature, might, by pressure upon some more or less fixed vascular structures, cause partial or complete occlusion.

From a practical standpoint, the location of the vascular invasion or occlusion is of great importance in determining the operability of the tumor. For instance, less than 1.5 centimeter is insufficient for satisfactory ligation of the root of the pulmonary vessels so that this becomes a definite indication of inoperability. Invasion by the growth of inaccessible places like the mediastinum, as indicated by obliteration of vascular structures, also is evidence of inoperability of the growth. Pericardial involvement, because of its serous lining, renders spread of the tumor easy, and its extirpation practically impossible.

In this series, in 28 of 45 cases (62 per cent), the diagnosis of cancer of the lung, made by angiocardiographic examination, was confirmed at autopsy or by biopsy. Figures compiled by others derived from ordinary roentgenographic examination alone, when correlated with the clinical history, but without the aid of angiocardiography, would indicate a similar percentage of correct diagnoses. Such series, however, are not comparable. It must be borne in mind that the conditions under which these cases were assembled were not comparable to those used by the essayists. They had the advantage in many instances of repeated roentgen observations often extending over periods of many weeks before a final diagnosis was made; such delay was permissible at that time, since nothing curative could be done for the patient. On the other hand, the essayists made their diagnoses at once, often from a single angiocardiographic examination without the benefit of prolonged roentgen observation of the patient.

It would seem, then, that the greatest benefits of angiocardiographic examination would be, first, the ability to make an immediate diagnosis while there is yet time for surgical procedure, and second, the information as to the extent of the growth and the structures involved, which this method may afford as a distinct advantage to the surgeon in his attack on the disease. By this means it will undoubtedly be possible to make a more decisive and prompt decision on the inoperability or operability of a growth and thereby to spare the individual a needless operation or to institute more prompt and effective action in the instances in which operation is indicated.

It must not be assumed that the interpretation of angiocardiographic examinations will be easy; only long experience gained by repeated roentgen examinations and correlation with pathological findings will serve to bring proficiency.

I congratulate the essayists and the others who have contributed to similar studies on their accomplishment and feel that they have made a distinct contribution to the field of radiology and to thoracic surgery.

Vol. 64, No. 2

CEREBRAL ARTERIOGRAPHY*

By ROBERT E. WISE., M.D., C. ROBERT HUGHES, M.D., *and* J. R. HANNAN, M.D.
Cleveland Clinic
CLEVELAND, OHIO

THE vascular channels of the brain have been demonstrated roentgenographically following injection of a contrast substance since 1927.[3] At the present time, both thorotrast and diodrast are used as the contrast media.[7,8,9–16] Because of the somewhat questionable danger of thorotrast[1,14,18,20] due to its radioactivity and the relative safety of diodrast, the latter in 35 per cent solution has been our substance of chioce. The contrast substance may be introduced by either the open[6–8] or closed method.[12–19] Because of simplicity and equally satisfactory results, the closed method is preferred.

Cerebral arteriography is best performed under anesthesia. The routine use of sodium pentothal eliminates the local discomfort associated with insertion of the needle and more important tends to decrease or eliminate any reaction due to the injection of the contrast medium.

TECHNIQUE

The patient is placed in a supine position, the head extending beyond the edge of the table and supported by a plywood board. By means of a chin-rest, the head is held in extension and fixed by adhesive tape to eliminate the possiblity of motion. With the head in this position, posteroanterior and lateral films are made by rotating the tube and Potter-Bucky grid for the desired films. It is our opinion that these two views afford more definite information than lateral stereoscopic views alone, especially when minimal lateral shift of the anterior cerebral artery is the principal finding.

After the patient has been anesthetized, an 18 gauge needle is inserted into the carotid artery. It is important to insert this needle so that the beveled edge is directed downward. With this modification the beveled edge of the needle lies within the blood flow and away from the arterial wall minimizing the chance of occlusion.

An average of 10 cc. of 35 per cent diodrast solution is injected rapidly for each view and exposures are made during the injection of the last 2 or 3 cc. of contrast medium. Following exposure of the lateral view, a second similar injection of diodrast is made for the posteroanterior view after changing the position of the roentgen tube and Potter-Bucky grid without disturbing the position of the head. If a venogram is desired, the exposure is made three seconds after completion of the injection.

In order to obtain more detailed roentgenograms, a rotating target tube should be used in conjunction with a movable Potter-Bucky grid. By employing long exposure times ranging from one and three-quarters to two seconds, it is apparent that a record of the flow of contrast medium through the vessels during that time will be recorded. The results obtained have, in our hands, been more satisfactory than those obtained with a manual cassette changer and taking multiple films over a three second period. This method affords visualization of the vascular tree on one film and enhances the chance of recording the presence of tumor stain.

Our experience with vertebral arteriography for demonstration of posterior fossa lesions is limited and will not be discussed. It is apparent, however, that this study is not as difficult to accomplish as originally thought and that its importance is becoming more firmly established.[9–19]

ANATOMY

There have been several recent articles describing the anatomy of the intracranial circulation.[4,8,9] A brief review is in order.

* Presented at the Fiftieth Annual Meeting, American Roentgen Ray Society, Cincinnati, Ohio, Oct. 4–7, 1949.

The internal carotid artery enters the skull by way of the carotid canal, passes through the cavernous sinus forming the carotid "siphon," giving rise to the ophthalmic, posterior communicating, and finally the anterior choroidal arteries before bifurcating into the anterior and middle cerebral branches. The ophthalmic branch is frequently seen during arteriography; the posterior communicating branch is seen occasionally; and the anterior choroidal branch is usually seen. The internal carotid then bifurcates into the anterior and middle cerebral branches.

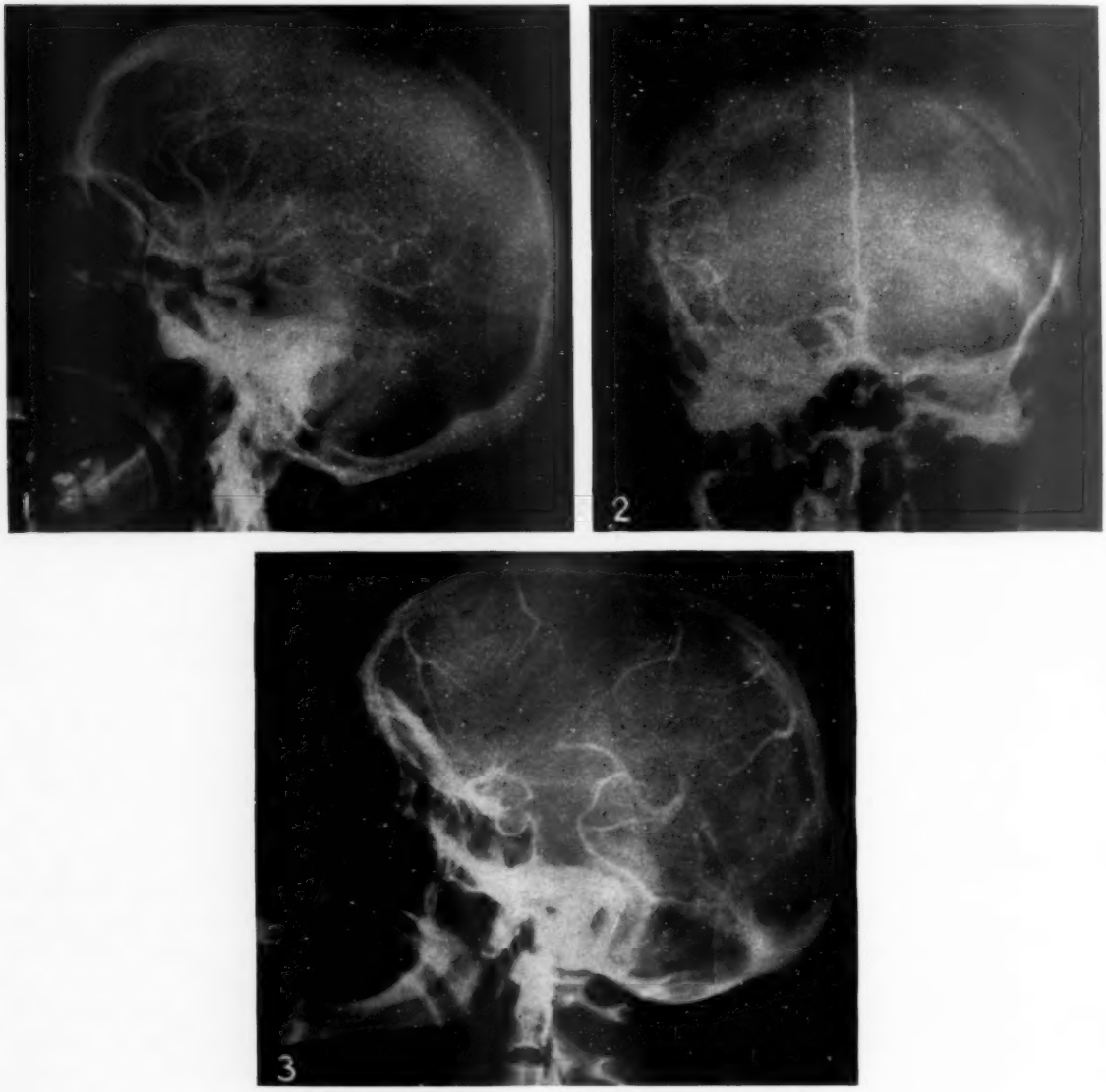
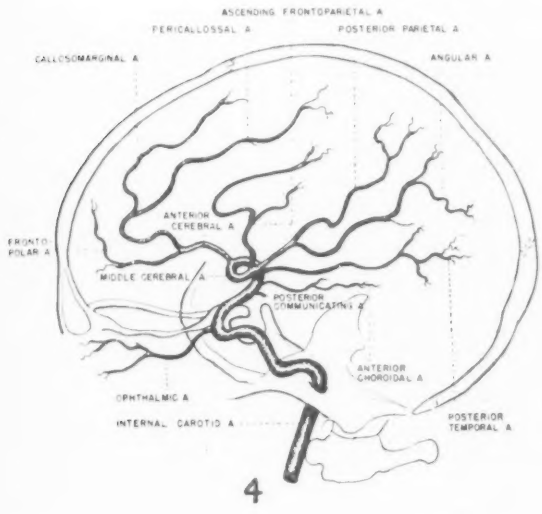


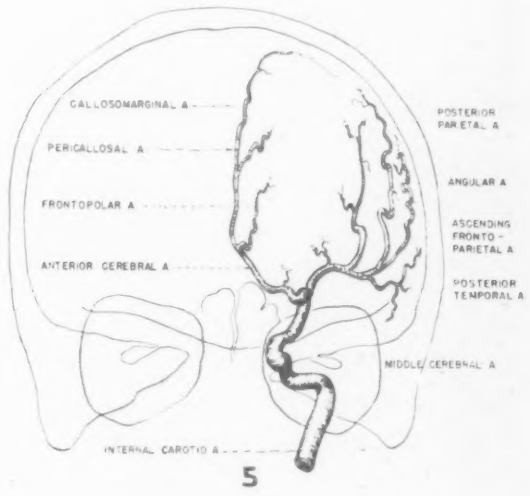
Fig. 1. Normal lateral view of carotid injection.
Fig. 2. Normal posteroanterior view of carotid injection.
Fig. 3. Normal venogram.

The anterior cerebral branch passes forward and medially to the longitudinal fissure, gives rise to the anterior communicating artery, ascends around the genu of the corpus callosum, gives rise to the frontopolar artery, passes backward along the

medial surface of the cerebral hemisphere and divides into the pericallosal and callosal-marginal branches.

The middle cerebral branch passes along and parieto-occipital convexity, and the posterior and superior portions of the temporal lobe respectively. These terminal branches of the middle cerebral artery are





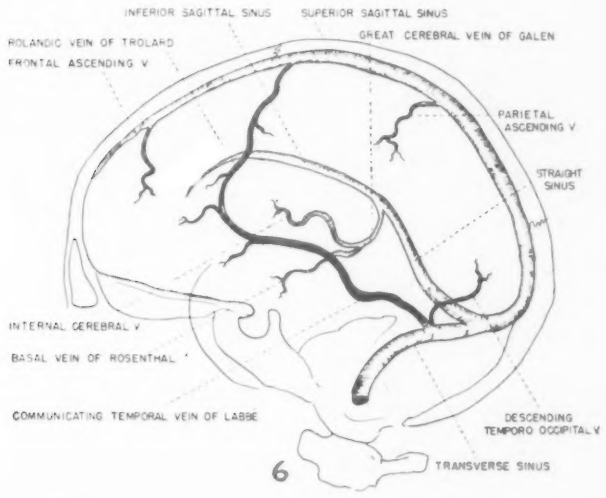


Fig. 4. Drawing of normal internal carotid branches in the lateral view.
Fig. 5. Drawing of normal internal carotid branches in the anteroposterior view.
Fig. 6. Drawing of normal venous system in the lateral view.

the sylvian fissure giving rise to small branches to the basal ganglia. The first large branch is the ascending frontoparietal. It then divides into three large branches which course diagonally backward and upward—the posterior parietal, angular and posterior temporal. They supply the convexity of the parietal lobe, angular gyrus usually considered as a group, *i.e.*, the middle cerebral group.

The major veins visible on the venogram are the frontal ascending vein, anastomotic vein of Trolard, and the parietal ascending vein, all of which drain into the superior sagittal sinus. The internal cerebral vein and the basal vein of Rosenthal unite to

form the short great vein of Galen which joins the straight sinus at the junction of the inferior sagittal sinus. The anastomotic vein of Labbe enters the transverse sinus in conjunction with the descending temporo-occipital vein (Fig. 1, 2, 3, 4, 5 and 6).

PATHOLOGIC CONSIDERATION

Tumors are space-taking lesions and have an abnormal vascular pattern. Because of this, cerebral arteriography lends itself to the diagnosis of these lesions. By means of the vascular displacement, localization of the tumor may be established and by visualization of the vascular pattern or so-called tumor stain an estimate as to the type of the tumor present may frequently be made.[11] The type of vascular displacement one may expect from tumors in different sections of the brain has been rather well established.[10]

Frontal lobe tumors generally show displacement of the anterior cerebral artery across the midline to the opposite side. The middle cerebral group is frequently displaced downward and the carotid siphon may be displaced downward and backward.

Parietal lobe tumors vary somewhat in the picture they present depending to a certain extent upon their anteroposterior relationships. Those located more anteriorly displace the anterior cerebral artery beyond the midline while those located more posteriorly will displace the terminations of the pericallosal and callosal marginal branches beyond the midline. The parietal tumors frequently show downward displacement of the middle cerebral group.

Temporal lobe tumors show a characteristic vascular displacement. There is elevation of the middle cerebral group visualized on both the lateral and posteroanterior views, and frequently straightening of the carotid siphon with displacement of the anterior cerebral artery.

Occipital lobe tumors are infrequently described in the literature, but upward displacement of the terminal third of the middle cerebral group and at times the pericallosal artery have been described.

List and Hodges[11] described the "tumor stain" or vascular patterns frequently found with certain types of neoplasms. They emphasized that these patterns are not always found but, when present, are of diagnostic value.

Meningiomas were found to possess a typical vascular pattern in addition to being characterized by close association with the brain surface and causing a somewhat circumscribed displacement of the adjacent vessels away from the table of the skull. A network of vessels of capillary or nearly capillary size was found. A double blood supply was described, *i.e.*, arising from both internal and external carotid branches. The vessels arising from the meningeal branches were enlarged and tortuous and ended in a dendritic cluster of small vessels at the dural attachment.

List and Hodges also described findings suggestive of glioblastoma. They are diffuse infiltrating tumors and frequently show a tumor stain of which they describe two types. In the first, there is an irregular network of fine criss-crossing vessels with perhaps a few larger sinusoid vessels; and in the second, there is a very coarse and bizarre vascular pattern somewhat resembling an arteriovenous malformation. Hodes *et al.*[8] described a tumor stain found with oligodendrogliomas. Numerous tiny faint blood vessels were seen radiating into the tumor in a somewhat parallel manner similar to that occasionally noted in glioblastoma multiforme. They also described a capillary stain seen with the venogram.

In our series, 5 cases were diagnosed microscopically as malignant astrocytoma. In 2 of these, arteriography showed an extremely fine vascular network in addition to vascular displacement. However, the stain could only be interpreted as being suggestive of a vascular type of neoplasm, but not specific for a particular type of tumor.

CASE REPORTS

Case 1 (Fig. 7). The patient was a nine year old girl who was first seen in 1943 at the age of four with one year history of grand mal seizures.

At that time a diagnosis of idiopathic epilepsy was made. Dilantin and phenobarbital were prescribed. She was not seen again until December, 1948. The grand mal seizures had continued. Six weeks prior to the second examination she developed periodic severe headaches of two and three hours' duration associated with screaming and vomiting. Three weeks later, jacksonian seizures developed involving the right side of the face and were associated with episodes of headache of one to three hours' duration. There were two episodes of vomiting.

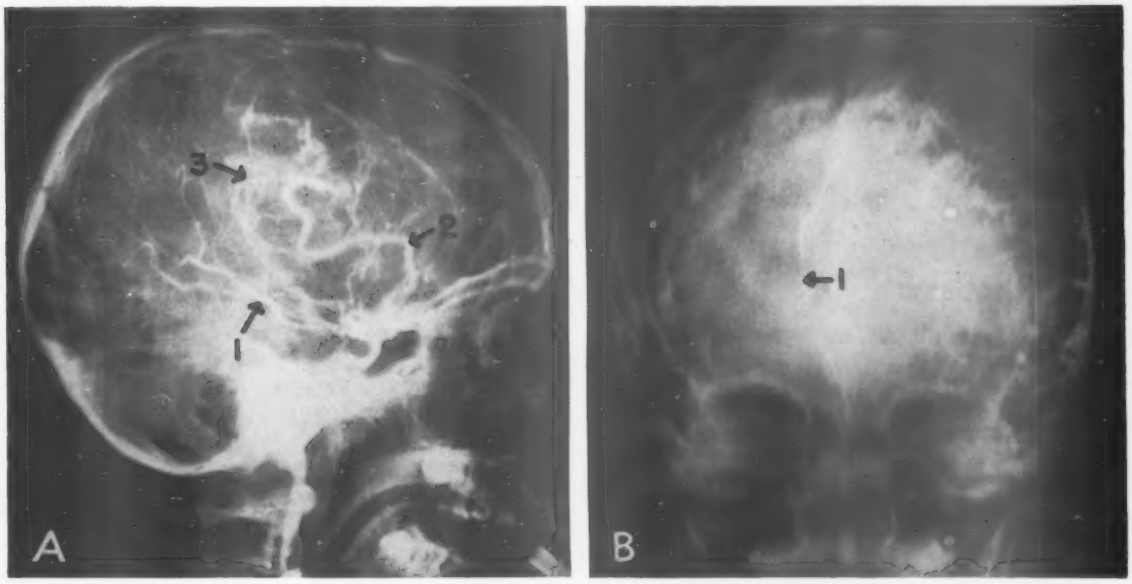


Fig. 7. Case 1. (*A*) *1*, downward, displacement of middle cerebral group; *2*, dilated artery; *3*, tumor "stain." (*B*) *1*, displacement of anterior cerebral artery across the midline. Diagnosis, frontal lobe astrocytoma.

Physical examination revealed swelling and tenderness of the left temporal region, papilledema, weakness of the left side of the face, and diminished reflexes of the right side of the body. A bruit was heard in the left temporal region.

A left carotid arteriogram was made. This showed displacement of the anterior cerebral vessels across the midline and displacement of the middle cerebral group inferiorly and medially. A large tumor stain was visible in the posterior frontal region and was associated with a large dilated spiral vessel that filled in the arterial phase.

Left frontal craniotomy was done. An extremely vascular, multicystic tumor beneath the dura was found. A large portion of the lesion was removed piecemeal. As the overlying skull was considerably thinned, a tantalum plate was used to close the defect.

Pathological diagnosis was astrocytoma.

Comment. The vascular displacement in this case is characteristic of that usually seen in a frontal lobe tumor. The tumor stain is associated with the dilated vessel leading into the stain and is very suggestive of the findings often described in cases of glioblastoma multiforme. The pathological diagnosis of astrocytoma illustrates the necessity of caution in attempting to make a specific diagnosis on the basis of tumor stain.

Case II (Fig. 8). The patient was a male, aged thirty-two, who first was seen at the Clinic on July 23, 1948, complaining of numbness of the left side of the face. There was evidence of anesthesia of the cornea and hypesthesia of the left fifth nerve. There were no other abnormal neurological findings.

Lumbar puncture revealed 3 cells per cu. mm.; no globulin, Wassermann and Kahn reactions negative and 61 mg. of total protein. A ligation of the left vertebral artery had been done elsewhere six months previously because of a suspected aneurysm on the basis of abnormal arteriographic findings.

At the time of admission to this institution,

a tumor of the left gasserian ganglion was suspected. Skull studies showed erosion of the tip of the left petrous apex. A left carotid arteriogram revealed slight anterior displacement and straightening of the carotid siphon and slight elevation of the middle cerebral group.

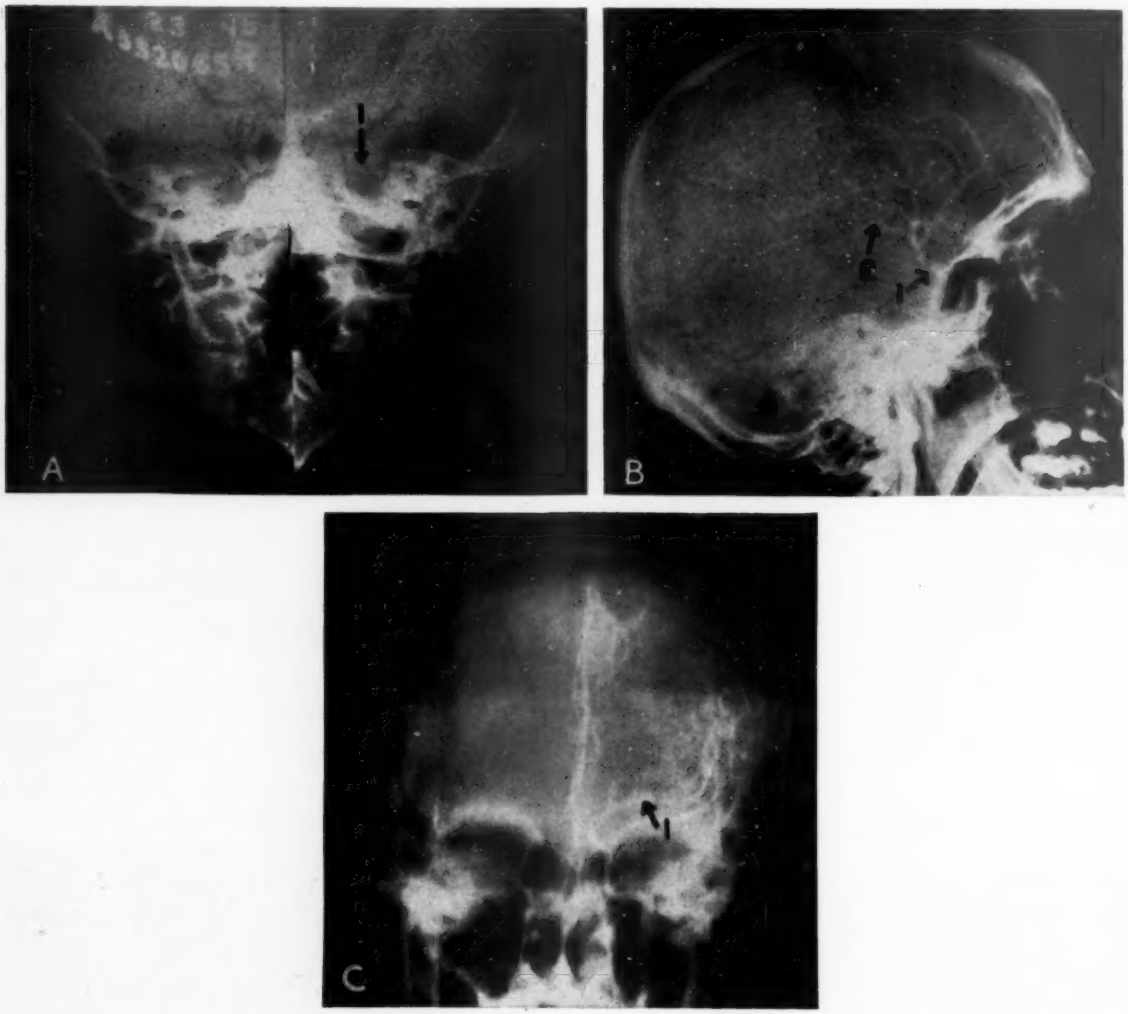


Fig. 8. Case II. (*A*) *1*, destruction of petrous tip. (*B*) *1*, straightening and anterior displacement of carotid siphon; *2*, elevation of middle cerebral group. (*C*) *1*, elevation of middle cerebral group. Diagnosis, meningioma arising in sheath of gasserian ganglion.

A left temporal exposure was carried out. In the floor of the middle fossa a mass covered with a double layer of dura was encountered. The tumor was believed to have originated in the sheath of the gasserian ganglion. The lesion was biopsied and it was reported as meningioma (gasserian ganglion) meningothelial; Type I, Variant II of Cushing and Eisenhardt. An attempt was made to remove the tumor a week later by means of a left suboccipital craniectomy, but severe bleeding was encountered from the extremely vascular tumor and the operation was discontinued.

Comment. Although a tumor stain was not evident in this case, it does demonstrate a tumor in close association with the surface of the brain and illustrates the vascular displacement seen in tumors of the floor of the middle fossa.

Case III (Fig. 9). The patient was a female, aged sixty-five, with a nine week history of speech difficulty. A brain tumor was suspected clinically.

A closed left arteriogram was performed. This

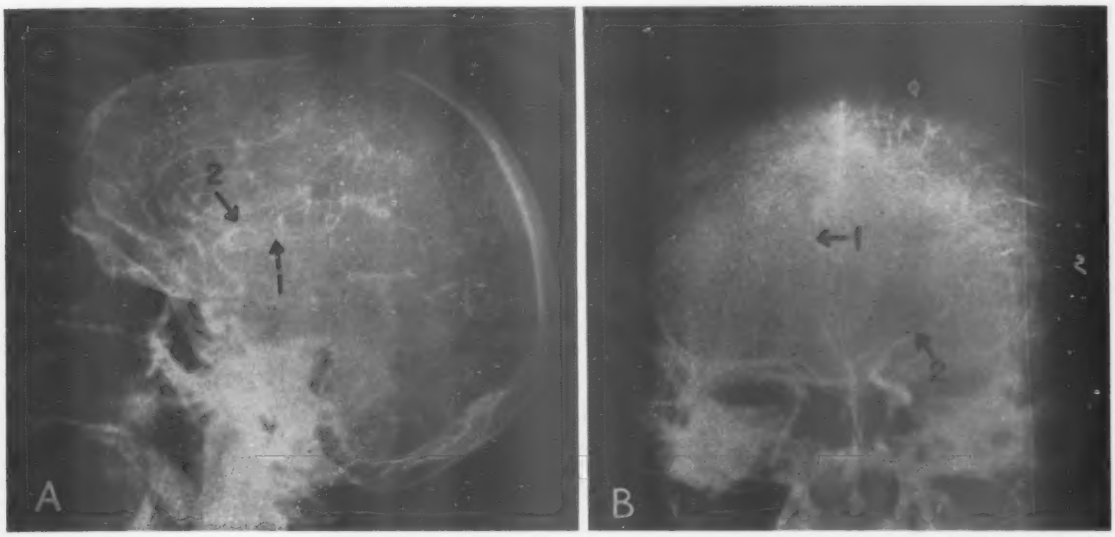


Fig. 9. Case III. (*A*) *1*, elevation of middle cerebral group; *2*, tumor "stain." (*B*) *1*, displacement of anterior cerebral group beyond the midline; *2*, elevation of middle cerebral group. Diagnosis, frontotemporal malignant astrocytoma.

disclosed elevation of the middle cerebral group, slight shift of the anterior cerebral artery beyond the midline and haze above the sella turcica representing a tumor stain.

A left frontal craniotomy was performed with subtotal removal of a left frontotemporal subcortical tumor.

Pathological diagnosis was malignant astrocytoma.

Comment. This case serves to illustrate the type of extremely fine vascular network seen in our cases of malignant astrocytoma.

Case IV (Fig. 10). The patient was a male, aged thirty-two, with a history of sudden onset of motor aphasia six months prior to examination. This was intermittent in nature and recurred frequently. Following onset of aphasia, he developed generalized headaches which later

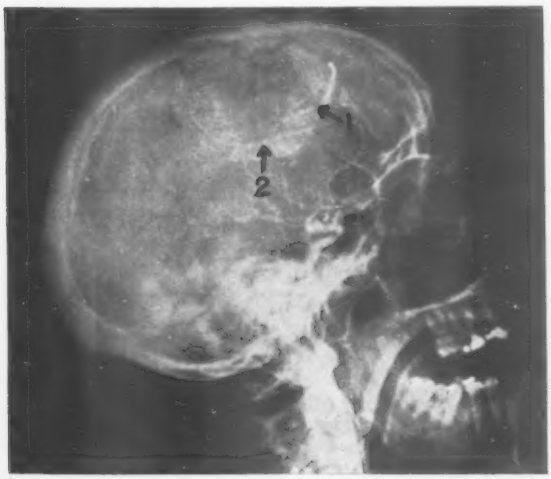


Fig. 10. Case IV. *1*, depression of pericallosal and callosal marginal arteries; *2*, tumor "stain." Diagnosis, frontal meningioma.

Fig. 11. Case V. *1*, straightening of carotid siphon; *2*, elevation of terminal aspect of middle cerebral group. Diagnosis, occipital spongioblastoma ependymale.

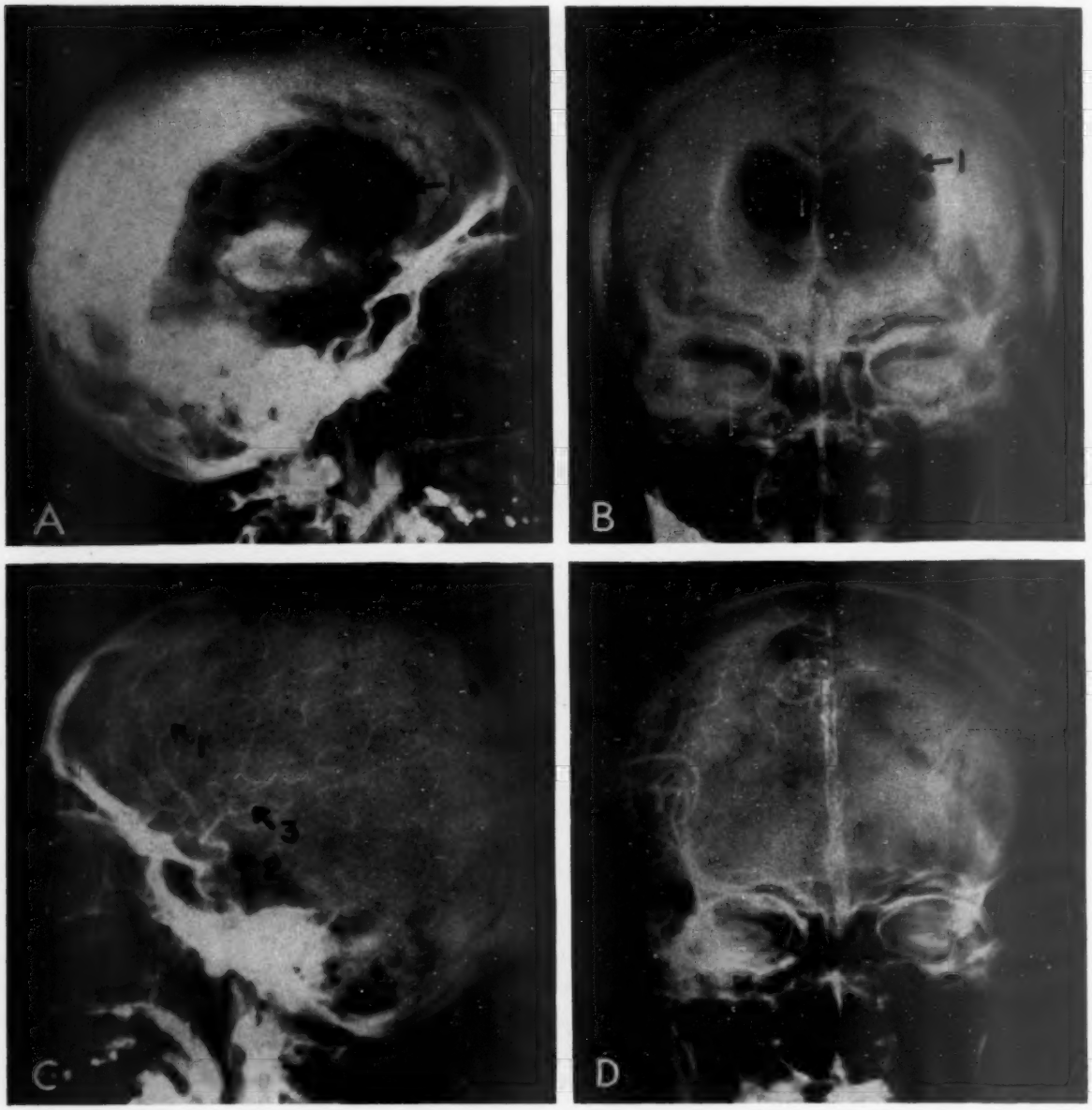


FIG. 12. Case VI. (*A*) (*B*) *1*, dilatation of lateral ventricles. (*C*) *1*, slight exaggeration of curvature of anterior cerebral artery and branches; *2*, straightening of carotid siphon; *3*, slight elevation of middle cerebral group. (*D*) Apparently normal posteroanterior arteriogram. Diagnosis, adhesions obstructing aqueduct of Sylvius.

localized to the left parietal region.

A left arteriogram was made. The lateral view only was satisfactory. This showed depression of the pericallosal and callosal marginal arteries with a crescent-shaped area of fine vessels representing a tumor stain.

A left frontal craniotomy was done and a large meningioma (Type II, Variant II of Cushing and Eisenhardt) was found and completely removed.

Comment. This case serves to illustrate a meningioma which demonstrated tumor stain arising from the cerebral element of the circulation. A stain arising from the meningeal element could not be detected.

CASE V (Fig. 11). The patient was a female, aged twenty-three, with a chief complaint of epilepsy. One year prior to examination she had noted flashes of light of short duration

which seemed to follow emotional crises. Six months later she developed convulsions of the grand mal type. She was hospitalized elsewhere, placed on anticonvulsant medication and discharged. Four months later she developed right frontal headache.

Physical examination revealed four diopters of papilledema bilaterally with complete left homonymous hemianopsia and early right sixth nerve palsy.

A lateral view of the right carotid arteriogram showed straightening of the carotid siphon and marked elevation of the middle cerebral group particularly marked in the terminal aspect.

A right suboccipital craniotomy was performed with amputation of the right occipital lobe.

Pathological diagnosis was spongioblastoma ependymale.

Comment. The vascular displacement in this case is consistent with that described for occipital lobe tumors. Taken in conjunction with the clinical history, the evidence was considered sufficient for surgical intervention.

Case vi (Fig. 12). The patient was a female, aged forty-five, with a three month history of left-sided headache associated with personality changes and frequent vomiting.

An arteriogram was made. The posteroanterior view was normal. The lateral view showed slight accentuation of the curvature of the anterior cerebral artery and its branches, slight elevation of the middle cerebral group and straightening of the carotid siphon.

A ventriculogram showed marked dilatation of the lateral ventricles. No air was visualized in the aqueduct or fourth ventricle.

A tumor producing hydrocephalus was suspected and a suboccipital craniotomy was performed. A tumor was not found but adhesions obstructing the aqueduct were found.

Comment. This case illustrates the minimal arteriographic changes that may be present in the face of very marked dilatation of the ventricular system.

VASCULAR LESIONS

Several types of vascular lesions lend themselves well to visualization by arteriography.[2,8,13] In this series, eight arteriovenous anomalies were demonstrated. The classical findings of tortuous arteries leading to a cluster of smaller vessels drained by enlarged, dilated, and tortuous veins were seen.

A lesion of this type may show changes in the encephalogram or ventriculogram but such changes would not be specific for a vascular anomaly. They are best demonstrated by means of arteriography because of the direct visualization through filling of the vessels.

In 1 of the 8 cases, the encephalogram was entirely normal but the arteriogram demonstrated an unusually large mass of small tangled vessels in the parietal region sharply demarcated at the midline.

Case vii (Fig. 13). The patient was a male, aged thirty-three, with an eleven year history of jacksonian seizures involving the right side. The seizures had been controlled fairly well by the use of anticonvulsants but shortly before examination the seizures had become more frequent.

Encephalographic studies were normal. An arteriogram was made. The lateral view showed large dilated arteries arising from the anterior cerebral artery leading to a well defined cluster of abnormal vessels and drained by large, tortuous, dilated veins. The posteroanterior view shows the lesion sharply demarcated at the midline.

Comment. This case illustrates the classical findings of congenital arteriovenous anomaly or malformation. It further illustrates the inadequacy of the encephalogram in demonstrating a rather massive vascular lesion which may be present and yet not be demonstrable by air studies.

Arteriovenous fistulae are usually acquired due to trauma, inflammatory disease, or arteriosclerosis, as contrasted to the arteriovenous anomalies or malformations which are usually congenital in origin.[17] The most frequent site of fistula is between the internal carotid artery and the cavernous sinus. One case in our series demonstrated a communication between

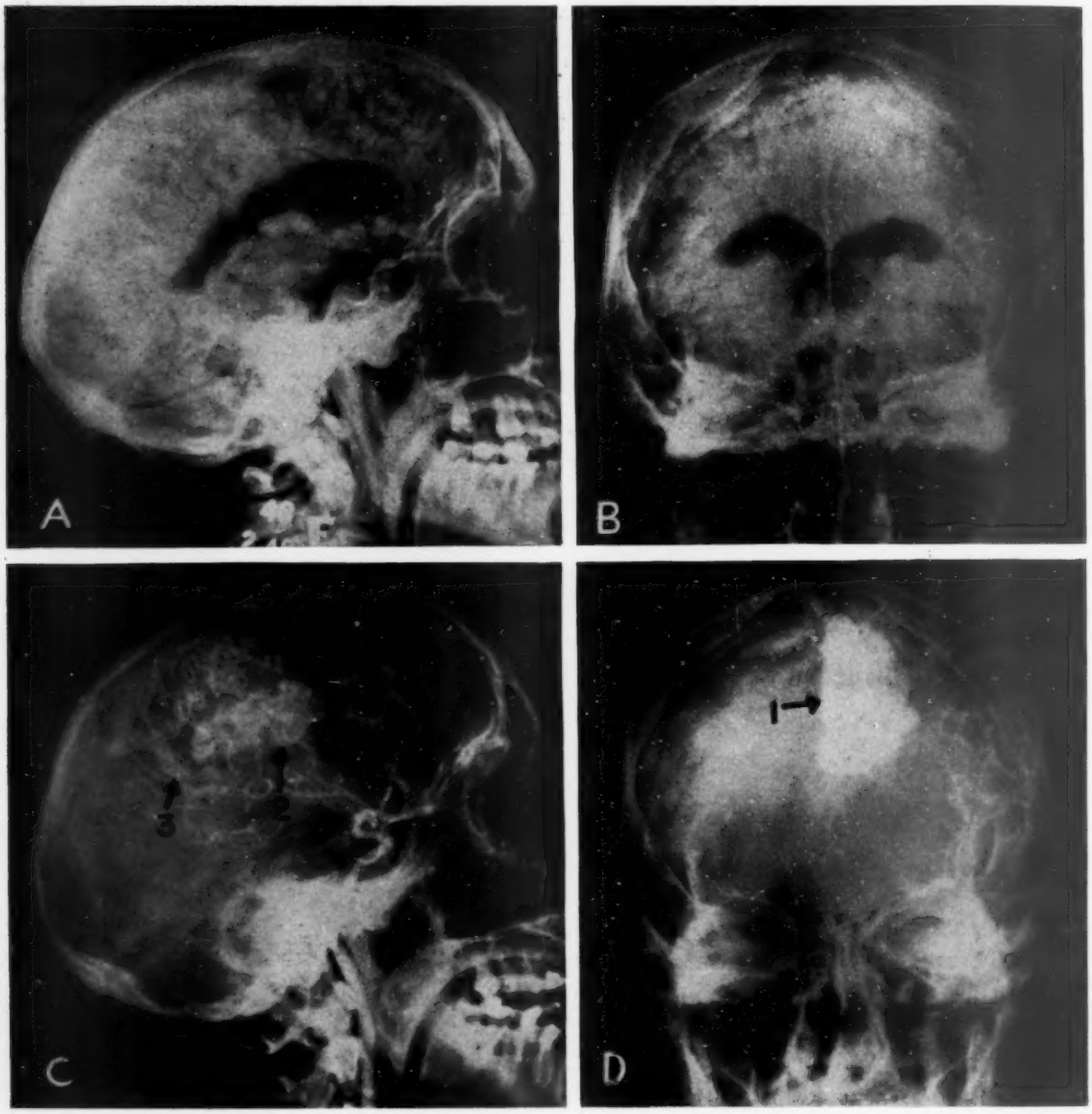


Fig. 13. Case vii. (*A*) (*B*) Normal encephalogram. (*C*) *1*, dilated branches of anterior cerebral artery; *2*, cluster of abnormal vessels; *3*, dilated tortuous vein. (*D*) *1*, cluster of abnormal vessels. Diagnosis, arteriovenous malformation.

the arterial and venous systems of the temporal lobe. It was believed to have been the result of trauma fourteen years previously. The remaining intracranial cases showed a communication between the internal carotid artery and cavernous sinus. The remaining 3 arteriovenous fistulae were external and involved vessels of the external carotid circulation.

Case viii (Fig. 14). The patient was a male, aged forty-two. Nineteen years prior to being seen at the Clinic he had fallen, sustaining a laceration above the left eyebrow. One and one-half years prior to examination he had awakened with a swelling of the left eye which persisted. Two weeks prior to examination he experienced a noise in the head described as a "pumping" noise. Upon examination a left exophthalmos was evident. An arteriovenous fistula was suspected.

Arteriogram demonstrated dye in the internal

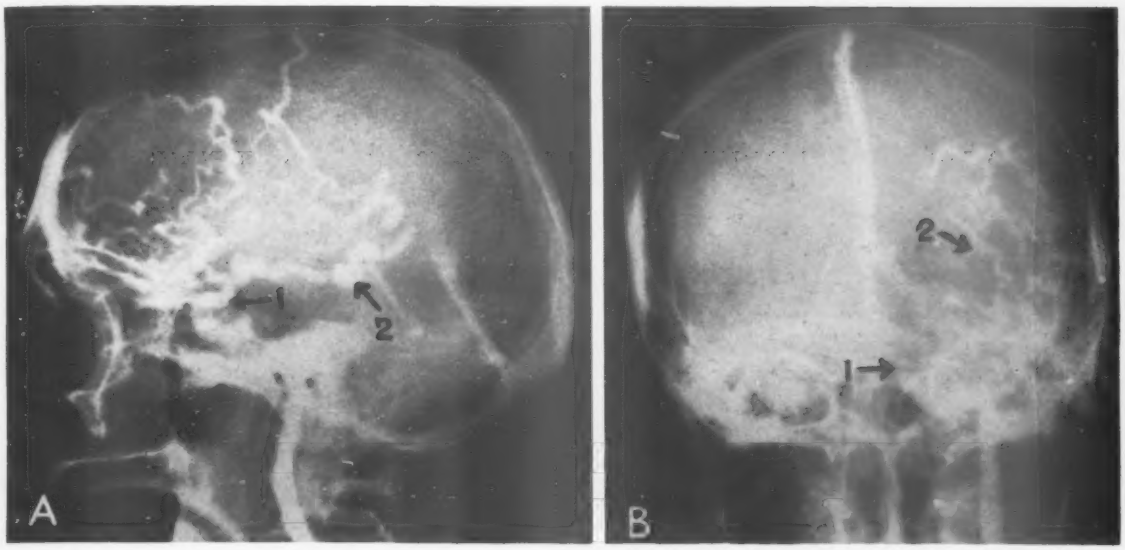


Fig. 14. Case VIII. (*A*) (*B*) *1*, dye visible in internal carotid artery as far as cavernous portion; *2*, large dilated veins. Diagnosis, arteriovenous fistula (internal carotid artery and cavernous sinus).

carotid artery as far as the cavernous portion at which point it was seen to pass directly into the venous system by way of the cavernous sinus. Beyond this point, large dilated veins were visible leading to the dural sinus.

Comment. This case demonstrates the classical findings of an arteriovenous fistula with dye passing directly into the venous system, elevating the pressure within that system, and dilating the veins.

Case IX (Fig. 15). The patient was a male, aged thirty-one, with a seven year history of headache. Upon examination a pulsating, ill defined mass with an audible bruit was present in the right temporal region.

An arteriogram of the external carotid cir-

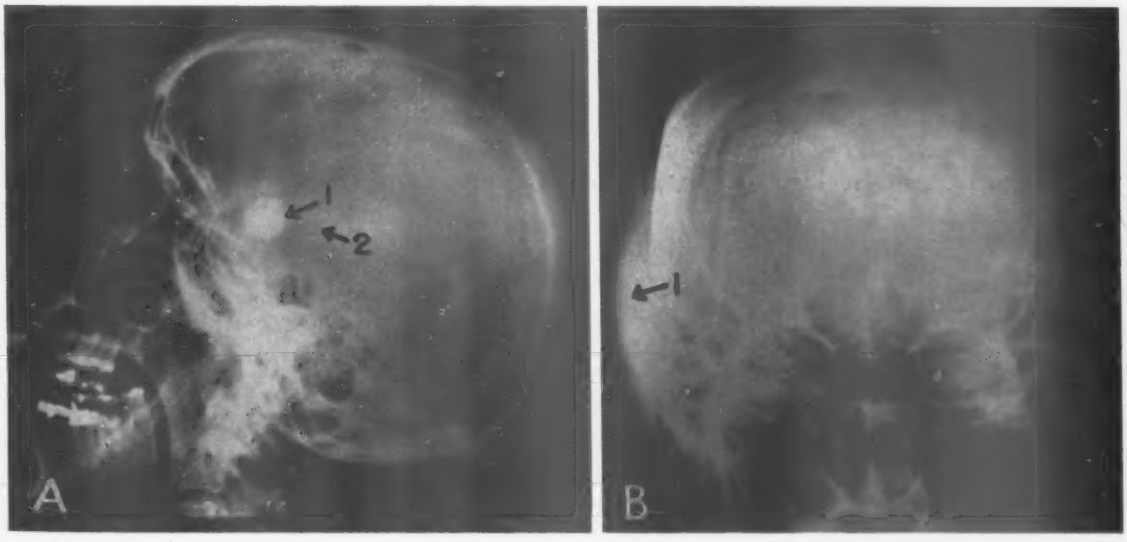


Fig. 15. Case IX. (*A*) *1*, round collection of dye apparently above sella turcica; *2*, external vessels visualized. (*B*) *1*, collection of dye is seen to lie external to the calvarium. Diagnosis, arteriovenous fistula involving temporal artery.

culation revealed, in the lateral view, a large rounded collection of dye visualized above the sella turcica. In the posteroanterior view, however, the collection of dye is seen to lie external to the calvarium. The diagnosis was an arteriovenous fistula involving the temporal artery.

At surgery, the temporal muscle was found to be swollen and pulsating. Nutrient vessels to the arteriovenous fistula appeared to come from beneath the zygoma. The vessel at this point was ligated. Pulsation was decreased and the palpable thrill ceased.

The pathological report was arteriovenous aneurysm, congenital (temporal artery).

Comment. The diagnosis in this case was made prior to arteriography but the procedure demonstrated the extent of the lesion and facilitated surgical approach.

Aneurysm of the internal carotid artery, circle of Willis and its branches may be suspected clinically, at times localized by calcification of the wall of the aneurysm or by destructive changes about the sella turcica, but by means of arteriography aneurysms may be visualized directly in a high percentage of cases and information as to size and location obtained.

Of the 25 aneurysms, 21 were demonstrated by arteriography. Error in technique prevented the diagnosis of 1 aneurysm; a circoid aneurysm communicating with the superficial petrosal sinus was not visualized by arteriography and in the other 2 cases the presence of aneurysm was not proven surgically though the clinical evidence substantiated such a diagnosis. Of the 21 aneurysms visualized by arteriography, 12 were located at the site of the post-communicating branch, 6 on the internal carotid, 2 on the anterior cerebral and 1 on middle cerebral arteries. In only 1 instance was a bilateral aneurysm encountered, and this was the only case in which calcification of the wall of the artery was seen.

CASE X (Fig. 16). The patient was a male, aged seventy, with a history of sudden onset of vertex headache nine months prior to examination. This was of several days' duration and cleared spontaneously. Twenty days prior to examination he developed persistent headache in the same region. There was loss of vision of the left eye and loss of libido.

Roentgenograms of the skull showed unilateral destruction of the floor of the sella turcica. Several flecks of calcium were visible about 1 cm. above the sella.

Arteriogram disclosed a large aneurysm of the cavernous portion of the internal carotid artery.

Comment. This case illustrates the value of arteriography in differentiation of changes in the sella turcica due to pituitary enlargement and destruction by an aneurysm. The patient had originally been sent to the Clinic with a tentative diagnosis of pituitary tumor.

CEREBRAL THROMBOSIS

Arteriography has a distinct place in the diagnosis of thrombosis of the internal carotid artery or its branches. Galdston *et al.*[5] describe 2 cases of internal carotid thrombosis in which the diagnosis was confirmed through the use of arteriography. Hodes[8] describes 1 case but emphasizes the necessity of not considering the diagnosis unless the findings are confirmed in a second examination.

In this series a definite diagnosis was made in only one case. It was that of a male, aged forty-one, in whom sudden left hemiplegia suggested occulsion of the right middle cerebral artery. The plain skull films were normal but an air encephalogram revealed atrophy of the right hemisphere. A right closed carotid arteriogram was performed. There was normal filling of all of the usual vessels with the exception of the middle cerebral and its branches. On the basis of this, in association with a suggestive clinical history, a diagnosis of middle cerebral thrombosis was made.

The diagnosis of cerebral thrombosis is difficult to make by arteriography as failure of filling of a vessel may at times have no pathological significance. In one case, re-injection produced filling of the

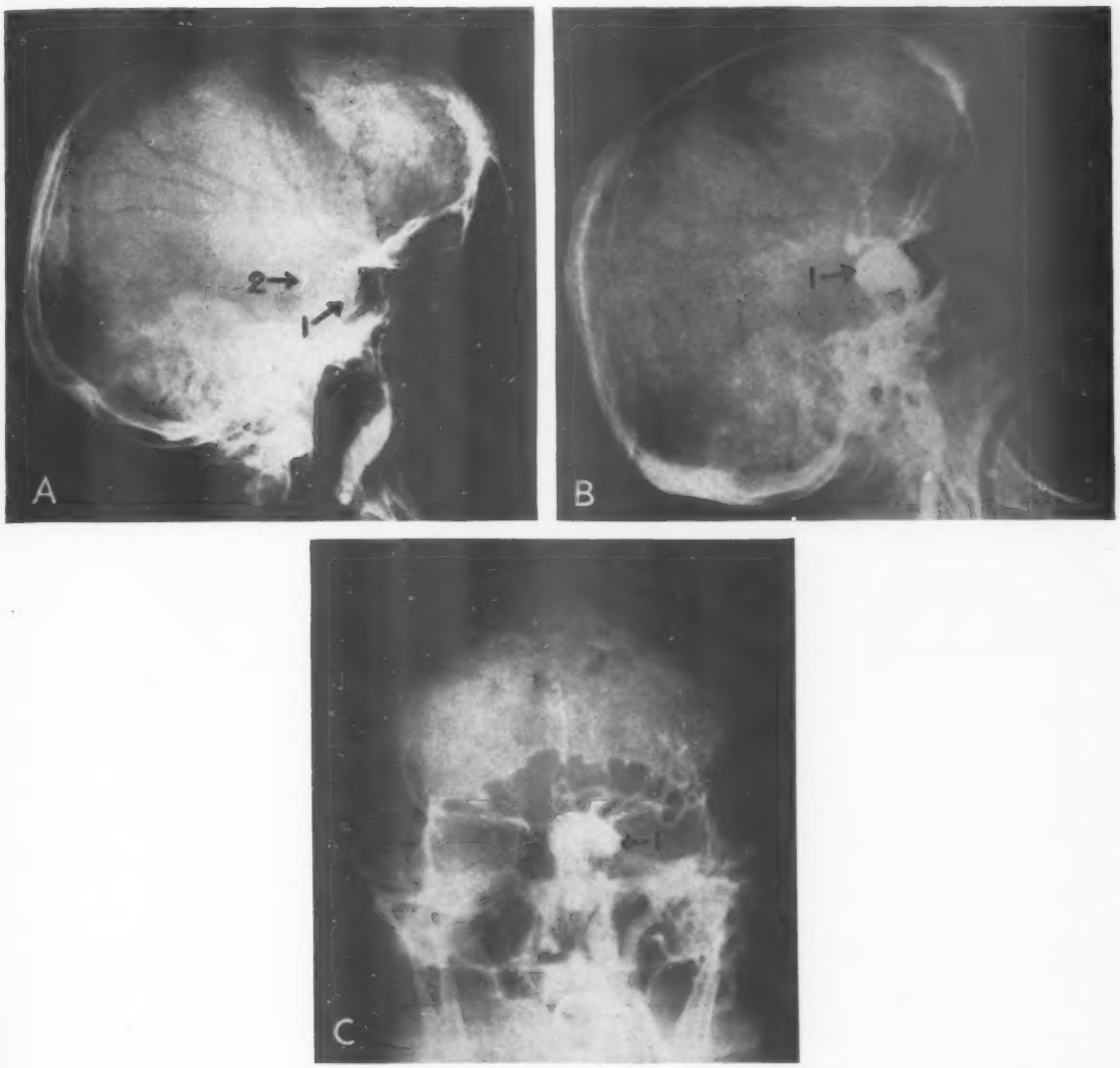


Fig. 16. Case x. (*A*) *1*, unilateral destruction of floor of sella turcica; *2*, small flecks of calcification above sella turcica. (*B*) (*C*) *1*, large aneurysm arising from internal carotid artery. Diagnosis, aneurysm of cavernous portion of internal carotid artery.

vessel in question. Thrombosis should not be diagnosed without adequate corroborative clinical findings.

It is also difficult to evaluate by arteriography alone those lesions which lead to the production of internal hydrocephalus because of the relationships of the vessels to the expanded ventricular system. The anterior cerebral artery and its branches are in close association with the corpus callosum which is affected but slightly, even with extensive hydrocephalus. The middle cerebral group also shows but slight displacement in these cases.

REACTIONS

In our experience to date, three reactions with one death have occurred with arteriography. The death was that of a male, aged fifty-four, who suddenly ceased respiration four hours following the arteriogram. The cause of death, however, was not

clear and autopsy findings were inconclusive. It could not be ascribed with certainty to diodrast. Another patient experienced mental confusion associated with a positive Babinski sign which cleared spontaneously in thirty-six hours. A seventeen year old girl developed jacksonian convulsions which cleared in thirty-six hours.

The cause of the reactions is not known. Poppen[16] recently has suggested that accidental injection of air bubbles into the stream of contrast material may account for some of the reactions which have been reported in the past. Sensitivity of the carotid sinus to diodrast has also been implicated. No generalized reactions such as urticaria have been encountered.

CONTRAINDICATIONS

There are contraindications to the procedure which must be weighed against the information to be gained. Advanced cerebral arteriosclerosis, extreme old age, severe cardiorespiratory disease, and known sensitivity to the contrast media are contraindications to the procedure.

Arteriography in the event of recent cerebrovascular accident is regarded as dangerous by Elvidge,[4] Turnbull,[21] and List[9] among others. More recently, however, Poppen[16] after reviewing 200 arteriograms, in most of which thorotrast was used, states that he does not hesitate to inject thorotrast or diodrast at any time in the presence of a recent subarachnoid hemorrhage, if an 18 gauge needle is used, since any increased intra-arterial pressure due to the injection is dissipated before the site of the aneurysm is reached.

SUMMARY

1. One hundred and fifty arteriograms were reviewed for purposes of this paper. In this series, there were thirty-eight tumors, twenty-five aneurysms, eight vascular anomalies, eight arteriovenous fistulas and one case of thrombosis of the middle cerebral artery. The remaining cases were normal or inconclusive due to technical difficulties.

2. Cerebral arteriography is a valuable adjunct to air studies, and is less discomforting to the patient.

3. Arteriography provides adequate localization data for space-filling lesions. In this series of thirty-eight tumors, twelve were localized by arteriography alone and five were more accurately localized by arteriography than by air studies.

4. It provides the only means of accurately demonstrating intracranial aneurysms, arteriovenous fistulas and arteriovenous anomalies.

5. Arteriography provides indirect evidence in cases of cerebral thrombosis that must be interpreted with caution. In some cases of internal hydrocephalus the findings by arteriography may also be inconclusive.

6. Cerebral arteriography is a relatively safe and simple procedure.

Cleveland Clinic
Cleveland 6, Ohio

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DISCUSSION

Dr. W. James Gardner, Cleveland, Ohio. Trephining the skull is one of the most ancient surgical practices. It is remarkable that whenever and wherever man attained the stage of culture corresponding to the early stone age, he began to carve holes in the skulls of his fellowman with his stone implements.

The development of modern surgery of the brain was an outgrowth of three significant discoveries of the 19th Century: namely, anesthesia, asepsis, and the doctrine of the localization of cerebral functions. The stories of the discovery of anesthesia and asepsis are well known. The development of the proof that the various functions of the brain are located in certain specified areas of the brain, however, was due to the contributions of many investigators.

The birth of modern surgery of the brain is generally considered to be November 25, 1884. On that day, a British surgeon, Rickman Godlee, employing the new principles of antisepsis developed by Lister for the first time and using anesthesia, found and removed a tumor of the brain which was localized purely by the newer neurologic methods. Then along came Quincke with his spinal puncture test, and about the turn of the century Röntgen described his marvelous x-rays.

With the use of the roentgen rays, neurosurgery took another leap forward making it possible to demonstrate between 10 and 20 per cent of surgical lesions within the skull cavity. Until that time, one had to depend for localization of brain tumors upon palpation of the outside of the skull and the demonstration of neurologic signs.

Then about twenty years later, along came Walter Dandy with his demonstration that the cerebrospinal fluid pathways which outline the shape of the brain could be demonstrated on the roentgen film after the fluid was removed and substituted with air. With that method, it is possible to demonstrate not all but the majority of expanding lesions within the cranial cavity.

Then some ten years later a Portuguese neurological surgeon, Egas Moniz, demonstrated the feasibility of cerebral arteriography. His procedure was not very popular at first because it required surgical exposure of the carotid artery in the neck. However, the percutaneous technique by Poppen, in which the needle is introduced through the skin into the common carotid artery and the dye injected without open exposure of the vessel, has led to a wide application of this diagnostic method.

This method can be applied readily with little morbidity. It is my present feeling that arteriography should be used in all cases of jacksonian epilepsy because a high percentage of those cases are due to vascular anomalies and malformations. We prefer to use it in nearly every patient who is suspected of having a tumor of the brain if the location of the tumor, at least its lateralization, is fairly evident. The procedure in our hands is carried out under pentothal anesthesia.

If the arteriograms are not diagnostic, they can be followed by ventriculography or encephalography. The morbidity of the procedure is extremely low.

One advantage of arteriography is that, when it discloses a tumor stain, the localization is unequivocal whereas in ventriculography the localization is arrived at usually by deduction.

Dr. Frederick O. Coe, Washington, D. C. I want to congratulate the speaker for presenting this material in such a fine form, but in the course of his paper he spoke about the use of thorotrast. As it happens, I was instrumental in the introduction of thorotrast in 1930. I injected the first case in July, 1931. I cannot be too emphatic in my statement that I do not think that it should be used because of the danger of the thorotrast getting into the surrounding tissue.

One rather unfortunate experience occurred at Navy Hospital. The day before I left for this meeting the patient, whom we had injected in July, 1931, called me up and asked whether she should sue the doctor who made the injection at that time. Her elbows now are both almost completely ankylosed by fibrosis; they are necrotic; they have broken down, and as we found at Walter Reed in some of the cases, sarcoma had already developed in this tissue.

I know that we usually cut down on the vein now, but there is always a possibility if thorotrast is used that it will get into the surrounding tissue, will form progressive fibrosis with continuous radiation from the thorotrast, and as I have said, in some cases sarcoma has developed.

ANGIOCARDIOGRAPHY*

ANATOMO-ROENTGENOLOGICAL FORMS OF THE TRANSPOSITION OF THE GREAT VESSELS

By AGUSTIN CASTELLANOS, M.D., F.A.A.P.
Associate Professor of Pediatrics, University of Havana, School of Medicine,
RAUL PEREIRAS, M.D.
Radiologist, Children's Hospital,
and
OTTO GARCIA, M.D.
Intern, Children's Hospital
HAVANA, CUBA

THE object of this investigation is to demonstrate that the cardiac outline has no value whatever in the diagnosis of transposition of the great vessels, due to the fact that the anatomical arrangement of the great vessels is constant and hence the cardiac outline changes greatly in different cases.

The cardiac outline depends on the anatomical shape of the cardiac cavities, but it also depends on the diameter, situation and direction of the aorta and the pulmonary artery. Since these vessels have variable anatomical characteristics, it would be an error to establish a standard that has to be the same for all cases of transposition of the great vessels.

Angiocardiography is the most exact method for the diagnosis of this anomaly, because it shows accurately the macroscopic anatomy of the cardiac cavities and of the great vessels.

Angiocardiography can show (1) the size, situation and general shape of the right and left cardiac cavities; (2) the diameter, situation and direction of the aorta and pulmonary artery, giving, as well, information about the origin of those vessels, whether it be the right or left ventricle.

We do not agree with some cardiologists in their description of a typical cardiac configuration in cases of transposition of the great vessels, such as Dr. Helen B. Taussig has recently given. According to Dr. Taussig the typical characteristics of this anomaly, in the anteroposterior position, is a narrow vascular pedicle, a concave mid-arch, and increase in the size of the right and left cardiac cavities. When there is association with a patent arteriovenous duct and foramen ovale, the left cavities are larger than the right cavities. When there is a high interventricular communication in addition to transposition, both right and left cavities are larger than usual. The same holds true when there is at the same time interauricular and interventricular communications. When there is a coexistence of transposition and complete interruption of the aorta, there is increase in the size of the left ventricle, but not of the right ventricle.

According to Dr. Taussig, the characteristic and constant fact, in the anteroposterior position, is the existence of a narrow vascular pedicle. This pedicle widens as soon as the patient is rotated to an oblique, left anterior position. Also constant according to Dr. Taussig, is the concavity of the mid-arch. The cardiac cavities are the only ones that change in the presence of other congenital anomalies.

The clinical material that gave us the basis for this study is the following: Three cases in which angiocardiography and autopsy were performed. One case in which angiocardiography was performed while the patient was alive, and at postmortem another angiocardiography was done (no permission for autopsy could be obtained from relatives). Three cases with angiocardiography still living.

* Read by title at the Forty-ninth Annual Meeting, American Roentgen Ray Society, Chicago, Ill., Sept. 14–17, 1948.

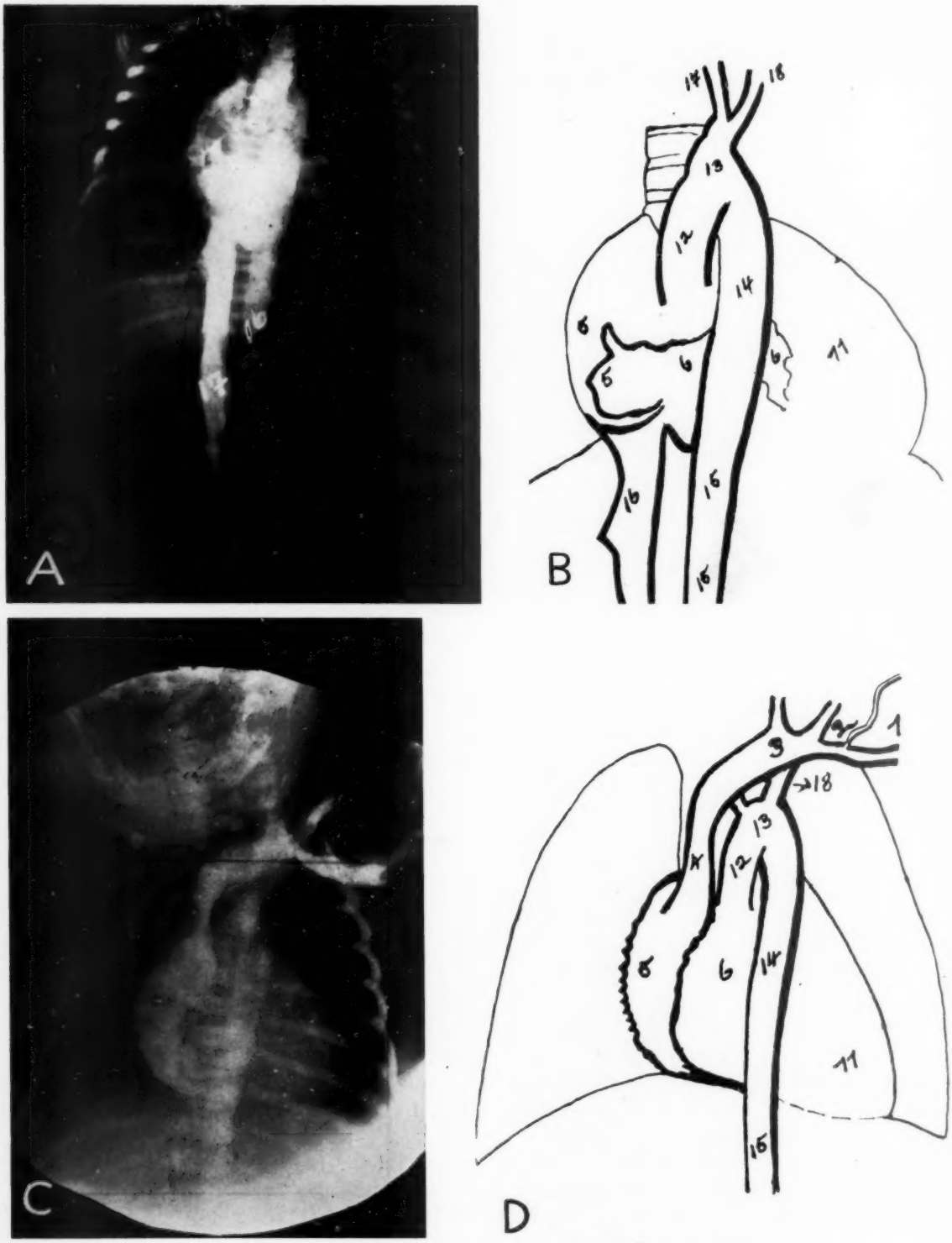
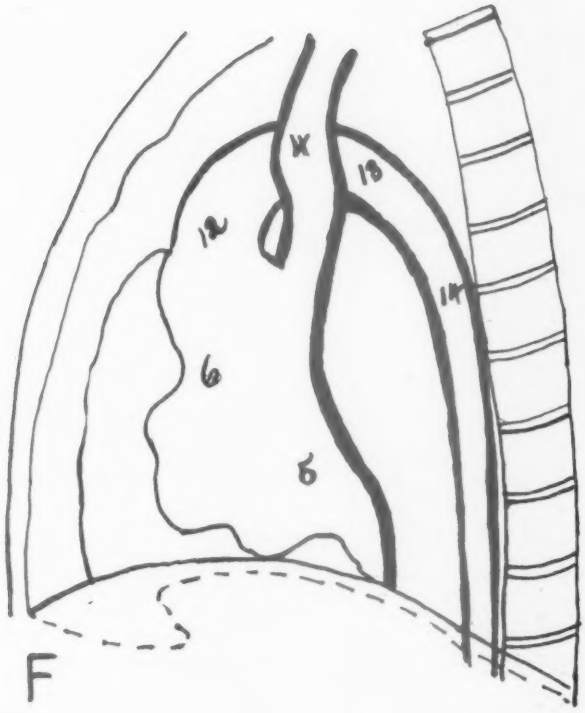
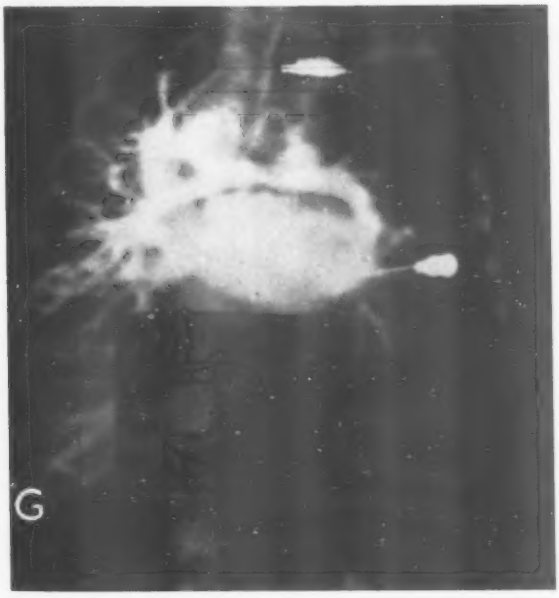
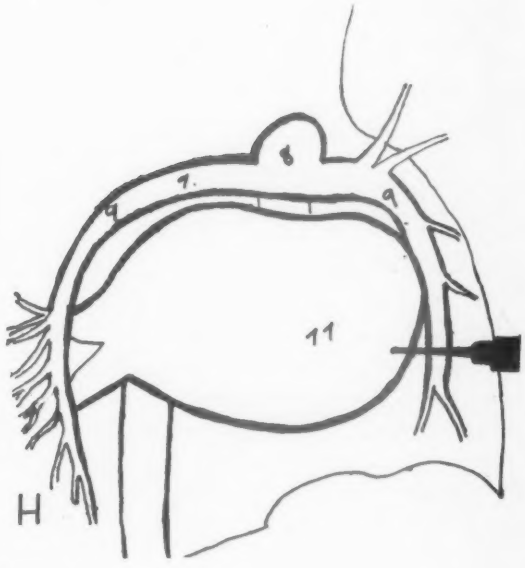


FIG. 1. Case 1. (*A*) Injection made into the saphena. Shows the inferior cava and the aortic system one and a half seconds after injection. Transposition type one. (*B*) Drawing from the angiocardiogram. (16) inferior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (15) abdominal aorta; (17) primitive carotid artery; (18) subclavian artery; (11) left ventricle.

(*C*) Angiocardiogram in anterior position, injection at the left side. Shows all of the aortic system and not the pulmonary artery. Transposition type one. (*D*) Drawing of the angiocardiogram. (1) axillary vein; (2) subclavian vein; (3) innominate vein; (4) superior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (15) abdominal aorta; (18) subclavian



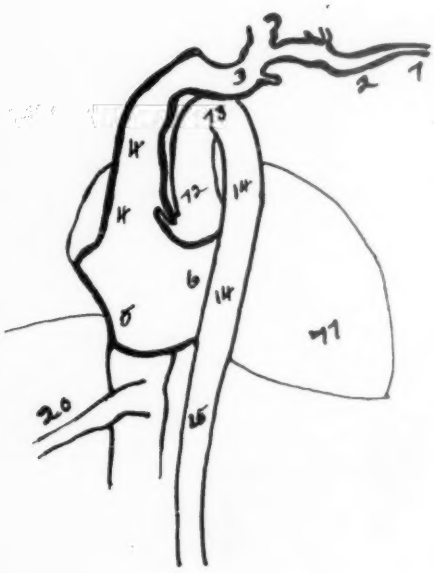




artery; (11) left ventricle (not opacified by contrast substance).

(*E*) Lateral view, one and a half seconds, shows the aortic system but not the pulmonary artery. Transposition type one. (*F*) Drawing of the angiocardiogram. (4) vena cava superior; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta.

(*G*) Angiocardiogram, postmortem, by puncture of the left ventricle. Pulmonary artery is seen arising from the left ventricle. Confirms type one diagnosis. (*H*) Drawing of the angiocardiogram. (Note the puncture needle.) (11) left ventricle; (8) pulmonary artery; (9) pulmonary branches (left and right). The aorta is not visualized.



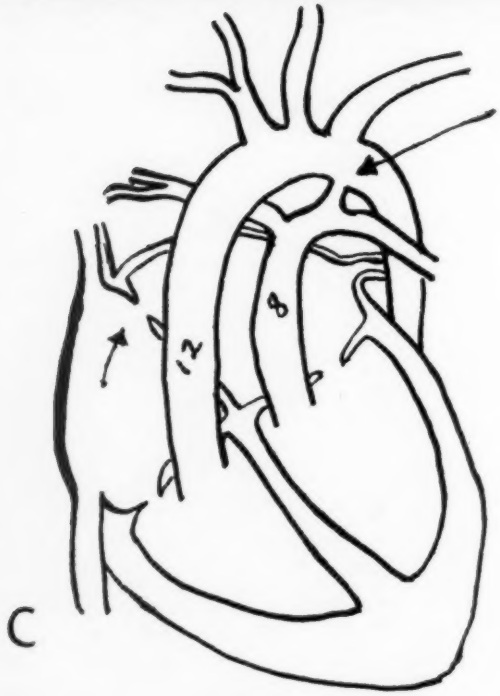


FIG. 2. Case 11. (*A*) J. P. Angiocardiogram in anterior position, injection at left side, taken one and a half seconds after injection. Aorta arising from right ventricle. Pulmonary artery not seen. Transposition type one. (*B*) Drawing of the angiocardiogram. (1) axillary vein; (2) subclavian vein; (4) superior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (15) abdominal aorta; (20) suprahepatic vein; (11) left ventricle (not opacified by contrast medium). (*C*) Transposition of the great vessels. Interauricular communication. Patency of the ductus arteriosus. Necropsy performed by Dr. J. J. Jimenez. Children's City Hospital of Havana, Cuba. Necropsy No. 1158.

ANATOMO-ANGIOCARDIOGRAPHIC TYPES OF THE AUTHORS

First Type. In this type, the aorta arises forward and toward the right of the pulmonary artery. The aortic arch ascends, to the left and backward, and it is situated normally over the left bronchus. The pulmonary artery is situated at the left margin

of the cardiac outline, its caliber being normal, or almost always diminished. The interventricular septum is generally permeable. The interauricular septum is closed in the majority of the cases. The arteriovenous duct is almost always closed, or partially so. The cardiac outline gives the image of a globular heart. The mid-arch is concave. The vascular pedicle may be normal or slightly dilated to the right.

The angiocardiogram in anteroposterior position in such cases is quite similar to that seen in cases of tetralogy of Fallot. In such cases the shadows of the superior vena cava, the right ventricle and the aorta are seen, the latter being intensely contrasted. Generally no image of the pulmonary artery or its branches is seen. There is no amount of opaque material within the left ventricle. The aorta descends to the left. The arch bends over the left bronchus, as it does normally.

In cases of tetralogy of Fallot with marked atresia of the pulmonary artery and its branches, the image seen may be similar; but in such instances, a small amount of radiopaque substance can be seen within the atresic artery. The left anterior oblique position is at times necessary for the diagnosis of the two malformations.

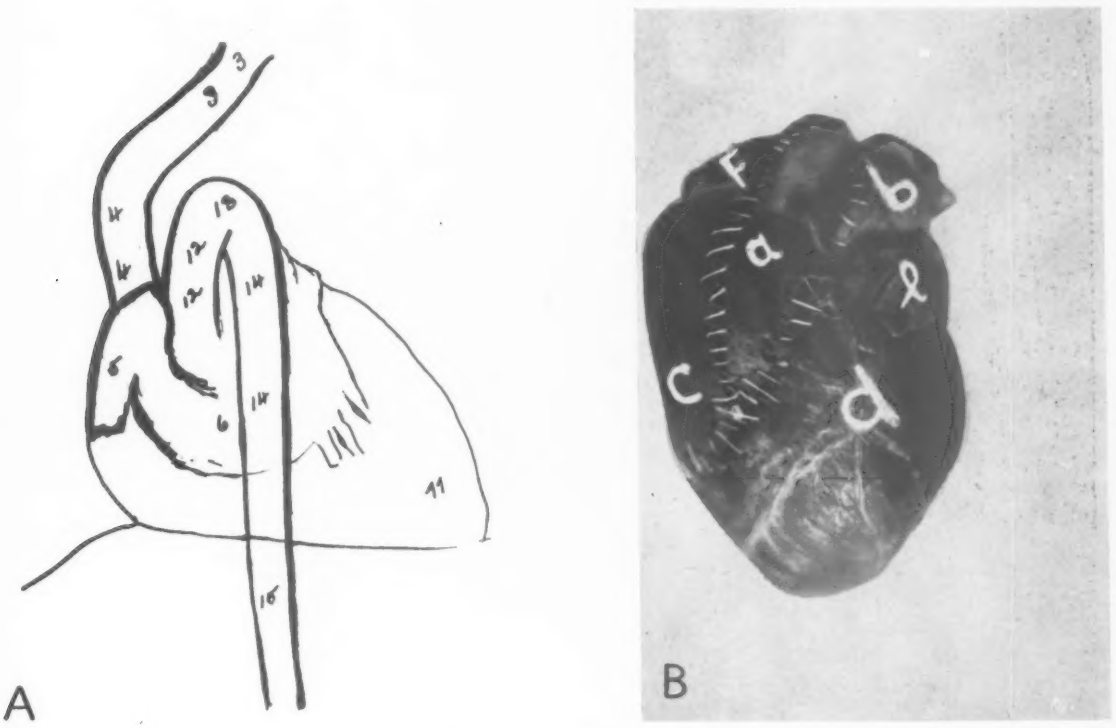


Fig. 3. Case III. (*A*) Drawing of the angiocardiogram of a child A. F. Dextro-angiocardiogram taken one and a half seconds after injection, showed aorta to the right of pulmonary artery, arising from the right ventricle, contrasted moderately by injection of a low concentration of the radiopaque substance. The interpretation of this drawing is as follows: (4) superior vena cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (15) abdominal aorta; (11) left ventricle, moderately hypertrophied. (*B*) Shows heart at necropsy; (a) aorta arising from right ventricle; (b) pulmonary artery arising from left ventricle; (c) right ventricle; (d) left ventricle; (e) auricular appendage, left; (f) auricular appendage, right.

Second Type. This is similar to the preceding, but the aorta arises almost at the midline, and ascends slightly to the left to bend over the left bronchus. The cardiac outline is similar to that of the first type. The angiocardiogram in the anteroposterior position is quite characteristic, because

the ascending aorta is situated almost at the midline and appears as an ascending vascular trunk which deviates slightly to the left in its upper portion to reach the left upper margin of the cardiac outline. aorta then descends in the posterior mediastinum, always at the left of it.

The pulmonary artery, normal or narrowed, is found to the right of the aorta and always behind it. The trunk of the

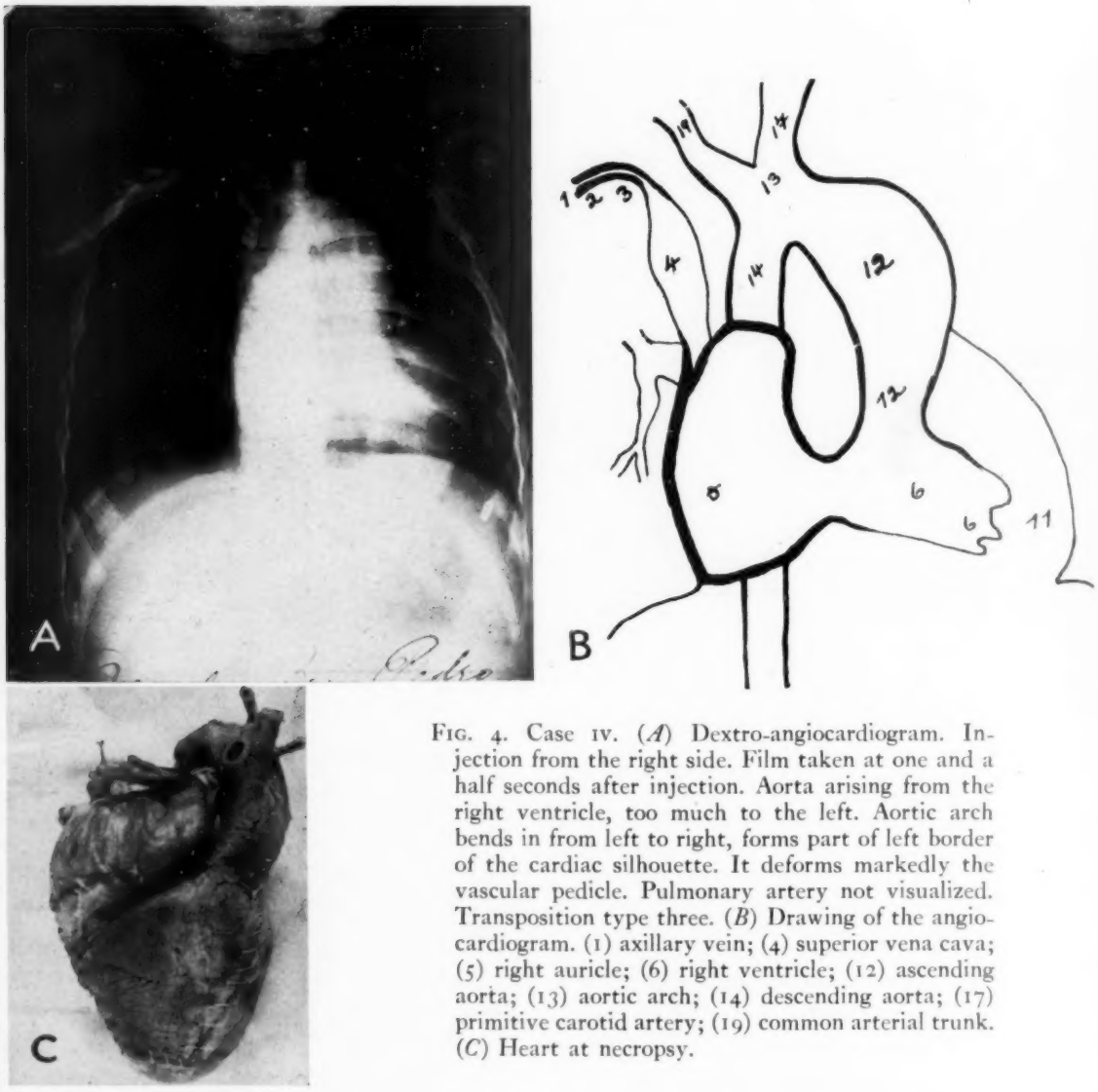


FIG. 4. Case IV. (*A*) Dextro-angiocardiogram. Injection from the right side. Film taken at one and a half seconds after injection. Aorta arising from the right ventricle, too much to the left. Aortic arch bends in from left to right, forms part of left border of the cardiac silhouette. It deforms markedly the vascular pedicle. Pulmonary artery not visualized. Transposition type three. (*B*) Drawing of the angiocardiogram. (1) axillary vein; (4) superior vena cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (17) primitive carotid artery; (19) common arterial trunk. (*C*) Heart at necropsy.

The pulmonary artery and its branches are not seen.

Third Type. In this type the aorta rises slightly or completely to the left of the midline; from this point it ascends vertically. After reaching the highest part of the left portion of the vascular pedicle, it bends toward the right to form its arch, which rides over the left bronchus. The pulmonary artery goes up and behind at the level of the midline, and in some cases to the right of the midline.

The cardiac outline seen in such cases is completely different from those seen in types one and two. The right margin is normal. The left ventricular arch is either normal or quite convex. The most important differences are seen above the left

ventricular arch. In some cases there is a prominent mid-arch with all the characteristics of a pronounced pulmonary arch; nevertheless it corresponds to the highest portion of the aorta, which, at this point, forms its arch. In other cases, there is a high long convex arch, which reaches the superior mediastinum. This arch is also formed by the aorta.

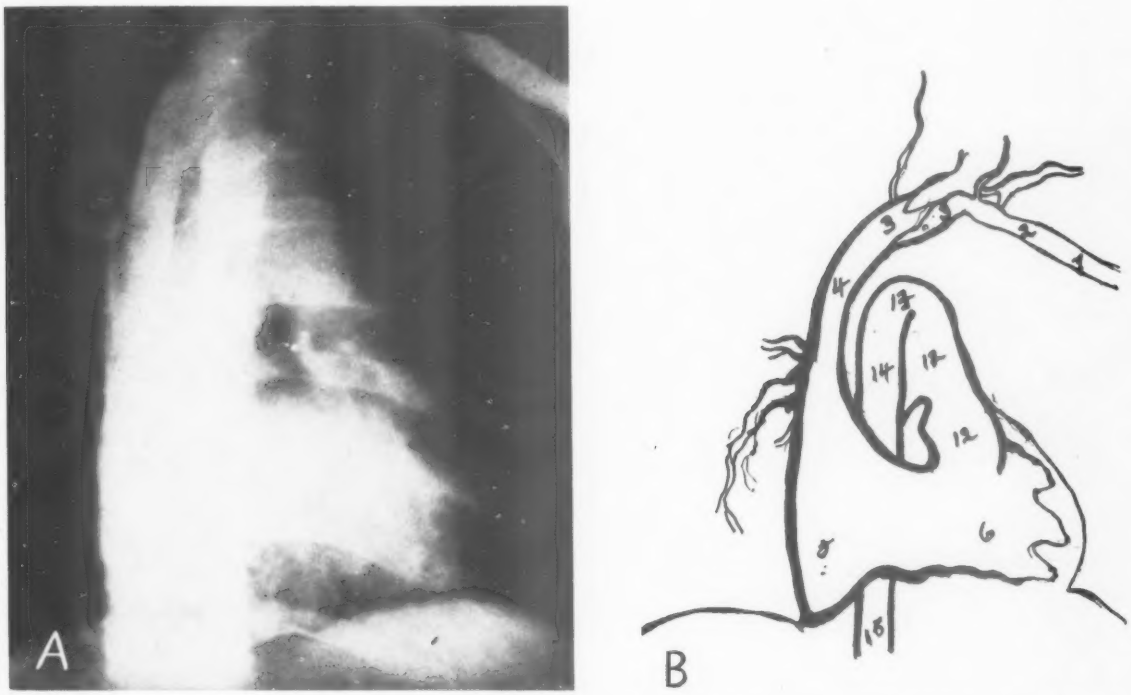
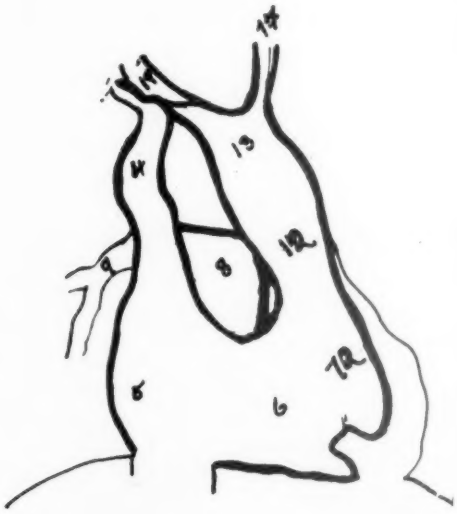


Fig. 5. Case v. (*A*) G. T. (Private case of R. P.) Angiocardiogram at one and a half seconds after left side injection. Note the aorta arising from the right ventricle. There is no superior left cava. The aorta comes out too much to the left of the median line, and the aortic arch bends in from left to right, forming part of the left border of the cardiac silhouette. It deforms greatly the vascular pedicle. Pulmonary artery not visualized. Transposition type three. (*B*) Drawing of the angiocardiogram. (3) innominate vein; (4) superior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (15) abdominal aorta.

The angiocardiogram in the anteroposterior position is characteristic. Both right auricle and ventricle are observed, as well as the infundibular region. The latter is found to the left of the midline and is continuous with the aorta, which ascends, and above the left bronchus bends itself, descending in the posterior mediastinum. The descending aorta can be seen at the space between the termination of the superior vena cava and the infundibulum.

In a very few cases, the radiopaque medium goes from the right ventricle to the left ventricle, but the margin of the right ventricle, as well as the subaortic region might appear with a blurred aspect, in cases associated with interventricular communication, in which blood from the left ventricle, on account of its higher tension, passes to the right ventricle. The pulmonary artery is never seen.

Fourth Type. In this type, the aorta arises always to the left of the midline, in anteroinferior position. From there, the aorta ascends, behind and toward the right, crossing the midline diagonally. In this way, it reaches the right superior mediastinum, and from here, it bends to form the arch which encloses in its concavity the right bronchus. Once the aorta reaches the posterior mediastinum, it descends, bending slightly to the left of the midline, or it continues lightly to the right of the midline.



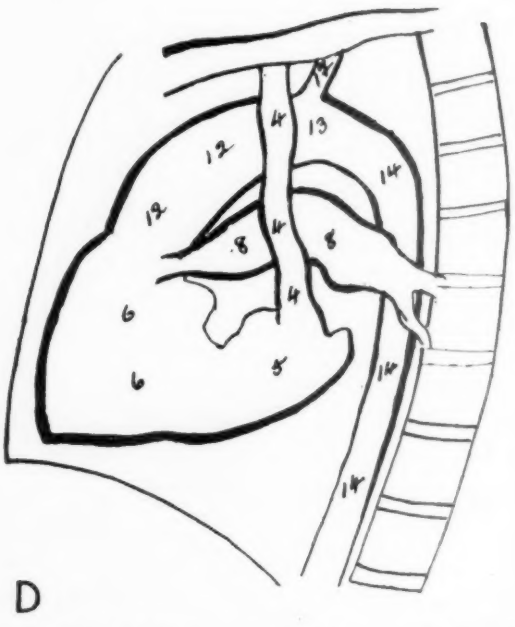


FIG. 6. Case VI. Patient, child C. (*A*) (Taken in private office of R. P.) Dextro-angiocardiogram. Injection at the right arm. Film taken one and a half seconds after injection. The aorta is visualized coming out from the right ventricle. Pulmonary artery coming out also from the right ventricle. Type two. Note how the aorta comes out to the left of the median line, and takes direction from left to right. (*B*) Drawing of the angiocardiogram. (4) superior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch; (17) primitive carotid artery; (18) subclavian artery.

(*C*) Angiocardiogram and lateral view. Film taken one and a half seconds after injection, on April 25, 1948. The aorta is seen coming out in an anterior position. Pulmonary artery comes out from below and from behind. Transposition type two. (*D*) Drawing of the angiocardiogram. (5) right auricle; (6) right ventricle; (4) superior cava; (12) ascending aorta; (13) aortic arch; (14) descending aorta; (17) primitive carotid artery.

The pulmonary artery is placed behind the aorta, and toward the right. It is usually atresic, and interauricular communication is frequent. Anomalies of the vena cava, and mainly the persistence of the left superior vena cava, is a fact that must be pointed out.

The cardiac outline is entirely different from that seen in the former types.

radiopaque. Immediately, the aorta, arising quite far from the midline and to its right, is seen. From here, it ascends obliquely and toward the left to reach the superior margin of the cardiac outline, where it bends downward, to occupy a position to the right of the superior mediastinum.

Neither the pulmonary artery nor its branches are observed.

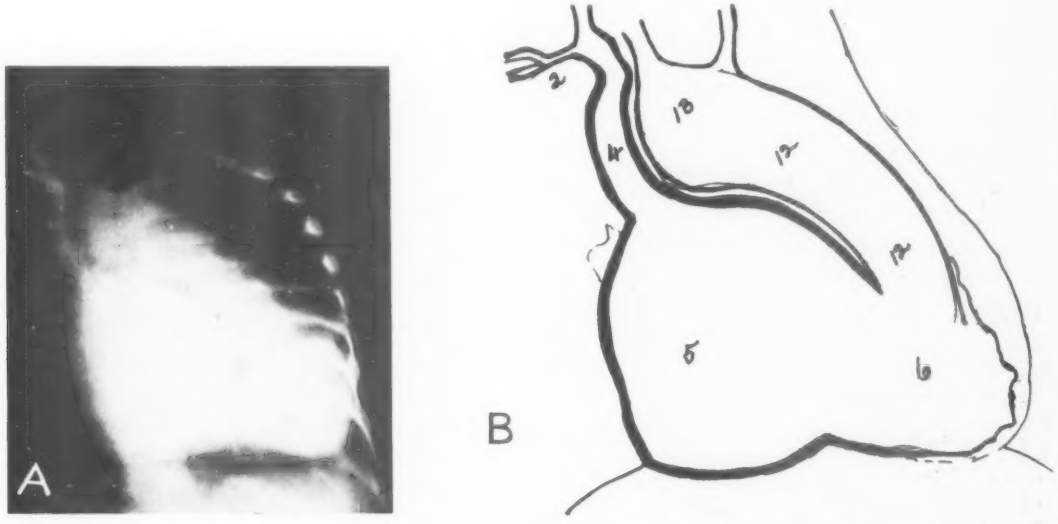


Fig. 7. Case vii. Patient C. D., female child. (*A*) Angiocardiogram, injection in the right arm. Film taken one and a half seconds after injection. Large diameter aorta coming out from the right ventricle, and the arch of which is at right of the median line. Pulmonary artery is not visible. Type four. (*B*) Drawing of the angiocardiogram. (4) superior cava; (5) right auricle; (6) right ventricle; (12) ascending aorta; (13) aortic arch.

The association of this type with large septal anomalies, mainly with interauricular septum defects, makes the external configuration of the heart quite variable, but in general, and even with the existence or not of such defects, the outstanding point is a wide vascular pedicle to the right; the aorta is plainly seen at the upper part of the mediastinum, to the right of the midline, where it forms a protrusion which is quite visible, even during roentgenoscopy, and on plain roentgenograms of the thorax. The medial and superior portions of the left superior margin form a long, slightly concave line.

The angiocardiogram in anteroposterior position is pathognomonic. The right ventricle and auricle are observed quite

Practical Value of Anatomo-Angiocardiographic Types

In the first place, angiocardiography allows an explanation, in all cases, of the cardiac outline, because, superimposing the angiocardiogram on the telecardiogram, we have evidence of what corresponds to the right cavities, what corresponds to the left cavities, and what corresponds to the great vessels. In addition, it has the advantage of introducing a functional notion, from the moment that we can know in cases of septal defects, the relative blood pressure of the right and left cavities. In the same way it shows, in cases of many vascular anomalies, which are the great vessels arising from the right or left ventricle, and even those that are riding over the septum.

In the special case of transposition of the great vessels, the angiocardiograms show with extraordinary accuracy whether the aorta arises from the right or left ventricle, or riding over the septum. The angiocardiograms also show whether the pulmonary artery arises with the aorta at the right ventricle, or at the left ventricle.

For the foregoing reasons, we consider angiocardiography as the best, most exact, most rapid, and easiest method for the diagnosis of transposition of the great vessels; at the same time, it gives the opportunity of making a practical classification of an anatomical nature.

The classification given by us explains precisely the cardiac outline of each case, and each anatomico-cardiographic type corresponds to a well defined anatomico-clinical entity.

ANGIOCARDIOGRAPHIC TECHNIQUE IN TRANSPOSITION OF THE GREAT VESSELS

The most important thing in diagnosis is dextro-angiocardiogram the film which is obtained during the course of injection, and just before 1 or 2 cc. of opaque medium remain in the syringe.

If the quantity of injected medium is sufficient, the film at the end of the injection will show the right cavities completely opaque, as well as all vessels arising from them. Hence the name "dextro-angiocardiogram" given by us to the roentgenogram taken by this procedure.

In effect, a great part of the contrast medium injected goes through the aorta, whether the aorta is riding over the septum or arising from the right ventricle. If there is a septal defect, interauricular or ventricular, or if there is a patency of the arteriovenous duct, part of the radiopaque medium goes from the right to the left cavities, but in any event, the quantity of contrast medium going to the left cavities is not enough to make the levo-angiocardiograms of any value. In this phase of levo-angiocardiography, the left cavities are poorly contrasted, and generally of no value for diagnosis.

CONCLUSIONS

1. We do not agree with some authors who describe a constant cardiac outline in cases of transposition of the great vessels, whether in cases of single or multiple anomalies.

2. The diameter, situation and direction of the great vessels is variable in different cases and that is why the cardiac outline is also variable.

3. Angiocardiography gives accurate knowledge of the origin of both aorta and pulmonary artery, and therefore with angiocardiography we can recognize the existence of transposition of the great vessels.

4. There are typical anatomico-angiocardiographic forms or variations of transposition of the great vessels which include all types described up to the present.

5. For the transposition of the great vessels, angiocardiography is the best diagnostic method, on account of its rapidity, innocuousness, and easy performance.

Children's Hospital
Havana
Cuba

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THE ROENTGENOLGIC MANIFESTATIONS OF ACOUSTIC NEUROMAS*

By BERNARD S. EPSTEIN, M.D.
BROOKLYN, NEW YORK

THE roentgenologic aspects of acoustic nerve tumors have been somewhat overshadowed by the relative ease with which the diagnosis can be made clinically. Nevertheless, this approach is important not only to complete the clinical picture, but also because the symptom pattern occasionally may be so atypical as to require roentgenologic assistance in establishing the diagnosis.

According to Schwartz[22] acoustic neuromas constitute from 8 to 9 per cent of all intracranial growths. Baker[1] reported its incidence as 1.5 per cent. Usually these tumors arise within the auditory canal from the perineurial or endoneurial connective tissue of the vestibular, or less often the cochlear portions of the eight nerve. Thence they extend inwards toward the posterior fossa of the skull as fairly well encapsulated tumors with soft granular contents.[4] When the tumor grows principally within the auditory canal, the petrous tip becomes decalcified and the internal auditory meatus increases in size. Should the major growth proceed outside the canal, it may impinge upon the adjacent cranial nerves, the cerebellum, pons and medulla oblongata with little effect on the adjacent bone. The trigeminal and facial nerves are most frequently involved, and the glossopharyngeal, vagus, spinal accessory and hypoglossal nerves may also be affected by the direct extension of the tumor.

Other tumors sometimes present in the cerebellopontine angle may arise from the trigeminal, the vagus or the glossopharyngeal nerves. Arachnoidal cysts simulating acoustic neuromas have been reported by Svien and Love.[24] Globus and Schwab[11] reported a vertebral artery aneurysm occurring in a male, aged fifty, with signs and symptoms suggesting the presence of an angle tumor.

In order to help evaluate the incidence and variety of roentgen changes present on plain film and pneumoencephalographic examinations, the data in 21 patients with verified acoustic neuromas were reviewed. The various projections of the skull including Law's position superimposing the internal and external auditory meati, Towne's and Stenvers' projections, frontal views showing the petrous pyramids through the orbits and axial views for the base of the skull were utilized. Seven patients had pneumoencephalographic examinations, including 5 ventriculograms and 2 lumbar pneumoencephalograms.

OBSERVATIONS FROM THE PLAIN ROENTGENOGRAM

From the Literature. Reports on the incidence of alterations in the size of the auditory meatus and erosion of the petrous pyramids vary considerably. Horrax and Buckley,[14] commenting on the difficulties encountered in differentiating pontine and cerebellopontine angle tumors, reported 8 cases of pontine tumors which almost completely filled the cerebellopontine angle and involved the cerebellar hemispheres and the brachium pontis. The cranial nerves on the side of the tumor, particularly the fifth, seventh and eighth nerves, either were imbedded in the tumor, displaced from the usual courses, or were unidentifiable. Roentgenographic examination of the porus acousticus in each case showed no change.

Camp and Cilley[3] measured the auditory meati in 609 normal petrous bone specimens and found variations in diameter up to 2.5 mm. between the opposite sides.

* From the Radiologic Service of M. G. Wasch, M.D., The Jewish Hospital of Brooklyn, Brooklyn, New York

Normal variations in diameter up to 2.5 mm. to 11 mm. were encountered. They preferred visualization of the auditory canals through the orbits for demonstrating the auditory meati. Towne's view was considered excellent for showing changes in the posterosuperior surfaces of the petrous pyramids. Stenvers' and Hodgson's projections were found to be less satisfactory.

Schwartz[22] recommended stereoscopic studies of the skull in the lateral projections together with views in the Stenvers' and Water's positions. He stated that roentgenograms of the internal auditory meati were usually not very successful, and suggested planigraphy as an aid in visualizing these structures. No data as to the incidence of changes in the various views was mentioned. Weinbren also suggested planigraphic examinations of the petrous bones. German and Wilson[10] favored Towne's projection for showing petrous pyramid changes. Olsen and Horrax[19] encountered changes in the petrous bones in 9 out of 15 cases of acoustic neuromas, but did not regard these as sufficient in themselves to warrant a final diagnosis.

Dyke[7] asserted that about half of the cases of acoustic neuromas produced sufficient bony erosion about the internal acoustic meatus and canal or the superior aspect of the petrous pyramid to be seen roentgenographically. In his opinion, the anteroposterior or posteroanterior views were best for the identification of such changes. On the other hand, Boldrey[2] found plain films of the skull to be quite disappointing unless striking erosion was present. Lysholm[17] stated that 90 per cent of the cases of acoustic tumor seen by him showed positive findings on plain film examination. Gonzalez Revilla[12] reviewing 160 cases of neurinomas of the cerebellopontine angle found roentgenographic reports of 114. Stereoscopic views of the base of the skull had been used mostly, and Towne's projection was employed infrequently. Half of his cases either had enlargement or definite destruction of the internal auditory meatus, and evidences of increased intracranial pressure were seen in seven. Young[30] stated that in most cases the tumor is sufficiently large to block the ventricular system and thus produce hydrocephalus, which causes pressure erosion of the dorsum sellae. Pineal displacement was observed in 22 per cent of cases by Vastine and Kinney.[28]

Present Series. The present group consisted of 21 patients varying from thirty to sixty-five years of age. Nine were males. Ten acoustic neuromas occurred on the right side, eleven on the left, and no bilateral tumors were encountered.

Towne's projection was used in 19 cases. Positive findings were disclosed in 6. In 3 of these the decalcification of the petrous pyramid and widening of the internal auditory meatus were apparent at a casual glance, while in the others the changes were considerably less extensive and might easily have been overlooked.

Projection of the auditory canals through the orbits was done in every case. Positive evidence of bone change was seen in 5 patients. The most advanced changes were present in the same 3 patients with marked alterations in Towne's view.

Stenvers' position was used in 15 cases, and was positive in 2. Both of these showed alterations in Towne's and perorbital views. The other patients with bone changes in the other projections showed no visible abnormalities in Stenvers' view.

Stereoroentgenographic examinations of the base of the skull were made in 6 patients and all were within normal limits. One of these had petrous bone changes visible in Towne's projection, while the others were without change in all views.

Views of the auditory meati in Law's projection were made in 16 cases and all were normal. Of these, 5 showed petrous bone changes in the other projections.

In 2 cases there was decalcification of the tip of the ipsilateral posterior clinoid process as seen in Towne's view. Neither of these had other bone changes.

There were very few roentgenologic in-

dications of increased intracranial pressure in any of the patients in this group. This is of interest inasmuch as pneumoencephalographic evidence of hydrocephalus was present in all the patients so examined, and is a manifestation of the slow progress of the disease. The sella turcica was normal in size in each patient, and a slight degree of sellar atrophy was seen in one. The pineal body was visible in 19 cases, and was normal in position according to measurements in the frontal and lateral projections. This is at variance with Vastine and Kinney's observation. Schwartz mentioned that pineal displacement forward, upward and laterally might occur, although in his opinion such measurements were not entirely reliable.

These data indicate that positive findings may be anticipated in approximately 30 per cent of patients with acoustic neuromas, and that Towne's and perorbital views of the petrous pyramids are the most advantageous. Evidences of increased intracranial pressure on plain film examination were infrequent.*

PNEUMOENCEPHALOGRAPHIC OBSERVATIONS

From the Literature. The data on pneumoencephalographic observations in patients with acoustic neuromas are rather few. Pilcher and Wilson[21] mentioned that their 3 cases of cerebellopontine angle tumor all had dilated lateral ventricles, and that 2 had dilated third ventricles. No data were given as to the sylvian aqueduct or the fourth ventricle. Ventriculograms were done in relatively few cases by Lysholm, Ebenius, Lindblom and Sahlstedt[16] because of the ease with which the diagnosis could be made clinically. They described 3 cases in which the salient findings on pneumoencephalography were hydrocephalus, lateral displacement of the aqueduct of Sylvius and fourth ventricle, and gentle dorsal displacement of the aqueduct and fourth ventricle. In one case an impression into the fourth ventricle was seen.

According to Johnson and List[15] large cerebellopontine angle tumors may displace or indent the pons and compress the aqueduct or fourth ventricle. Upward and anterior extension of such tumors may project the brain stem before it through the incisura tentorii. They concluded that the pneumoencephalographic findings resembled those associated with lateralized pontine tumors. Stone and Schulze[23] commented that posterior fossa tumors might elevate the tentorium on the involved side with consequent deformity of the inferior surface of the vestibule and posterior horn. Turner and Gardner,[26] in illustrations of sections of the skull in patients with acoustic tumors in situ, showed upward bulging into the inferior aspect of the temporo-occipital region.

Twining[27] described 2 cases of neuroma of the gasserian ganglion with protrusion of the tumor into the posterior fossa anterolateral to the pons, in which there was rotation of the fourth ventricle so that it assumed a rhomboid appearance in the lateral projection. One of these patients had a pronounced hydrocephalus, while there was neither dilatation of the ventricles nor displacement of the aqueduct of Sylvius or the fourth ventricle in the other.

Schwartz mentioned distortion, obliteration or enlargement of the homolateral portion of the cisterna ambiens and distortion of the sylvian aqueduct. Boldrey also noted contralateral displacement of the aqueduct of Sylvius and the fourth ventricle, and Olsen and Horrax reported a case with dilatation of the lateral and third ventricles and slight elevation of the ipsilateral occipital horns and contralateral deviation of the third ventricle.

Ventriculograms were made in 8 of Gonzalez Revilla's cases. Marked hydrocephalus and what was interpreted as definite evidence of block at the sylvian aqueduct was noted in 5. In 1 case there was

* Since this paper was submitted for publication we have observed 2 additional cases of acoustic neuromas. One of these had pronounced sellar atrophy; the other moderate atrophy.

moderate dilatation of the ventricular system without evidence of block or other deformity, and in 2 others the ventriculograms were normal.

Dyke asserted that ventriculography disclosed moderate dilatation of the lateral and third ventricles and the aqueduct of Sylvius. In most cases the fourth ventricle was not visualized, but occasionally it was displaced contralaterally or dorsally. The posterior part of the floor of the third ventricle might be encroached upon, an observation also mentioned by German and Wilson.

Pancoast, Pendergrass and Schaeffer[20] considered the findings in angle and cerebellar tumors to be quite similar except for more frequent block of the aqueduct of Sylvius in the former. They did not consider this observation as conclusive unless the ventriculographic findings were supported by erosion of the petrous ridge in the appropriate location.

Ecker[8] also pointed out that acoustic neuromas might produce filling defects in the posteroinferior aspect of the third ventricle and non-filling of the ipsilateral temporal horn. He considered these the result of upward herniation through the incisura tentorii.

An interesting case of aneurysm of the vertebral artery simulating an angle tumor was reported by Globus and Schwab. Ventriculography showed dilatation of the lateral and third ventricle and the aqueduct of Sylvius. The fourth ventricle apparently was not seen, and no displacement of the visualized chambers was noted. At necropsy a bluish mass measuring 1.5 by 1.0 by 0.75 inches was found compressing the inferior surface of the cerebellum and the left half of the medulla and pons, extending into the foramen magnum. The mass pushed the pons upward and toward the right, displacing the medulla and the upper cervical spinal cord. On sectioning the brain the ventricular system was found to be markedly dilated as far as the caudal end of the sylvian canal. At this point the aqueduct was shifted sharply to the right and was reduced to a thin oblique slit.

From the Present Series. There were 5 patients with ventriculograms and 2 with lumbar pneumoencephalograms in this series. None of these patients presented bone changes on preliminary examination with plain roentgenograms. The lateral ventricles were dilated in 5, incompletely filled in 1 and not seen in the last case which was studied by lumbar pneumoencephalography. In the latter case the callosal sulcus was quite elevated indicating the presence of hydrocephalus. The width of the ventricles measured from tip to tip in the anteroposterior projection varied from 5.5 to 7.5 cm. as compared with the upper limit of normal of 4.5 cm. mentioned by Davidoff and Dyke.[5] No displacement of the ventricles was noted in 5 patients, and in 1 a slight displacement toward the left occurred. In 1 there was slight narrowing and upward and lateral displacement of the ipsilateral temporal horn, and in another the ipsilateral occipital horn was elevated.

The third ventricle was seen in the frontal projections in 6 patients. It was dilated in 3 and at the upper limit of normal in the others. This measurement varied from 0.8 to 1.4 cm. as compared with the normal range of from 0.2 to 0.8 cm.

In 5 patients the third ventricle was well visualized in the lateral projection. No gross filling defects were seen in 4, while in 1 there was a suggestion of an upward convexity of the posteroinferior aspect of the third ventricle. This was difficult to evaluate. At first glance it was believed that the change might represent upward protrusion of the brain stem impressing into the third ventricle. However, measurements of the height of the third ventricle and distances of the suprapineal recess and aditus of the third ventricle to the posterior clinoid processes remained normal. There was, however, a bulbous dilatation of the anteroinferior aspect of that chamber, and an increased distance between the anteroinferior angle and the suprapineal recess indicating elongation. The apparent protrusion into the posterior aspect of the third ventricle was therefore considered a

change in configuration incident to dilatation of the chamber rather than a change due to extrinsic pressure.

The distance from the foramen of Monro to the aditus of the cerebral aqueduct was normal in all 5 patients, while the distance from the anteroinferior angle to the suprapineal recess was increased in 4. The distance between the suprapineal recess and the aditus, and from the aditus to the posterior clinoid processes were normal in the 5 cases in which this measurement could be made.[9]

Contralateral displacement of the third ventricle in the frontal projections was noted in 1 patient. In 5 others no deviation from the midline was seen.

The sylvian aqueduct was seen in 5 patients. In another there was obstruction of the aqueduct just beyond the aditus. In 3 patients there was contralateral displacement 1 cm., 2 cm., and 2.5 cm. from the midline respectively. Dorsal displacement of the aqueduct occurred in 2 patients, 1 of whom showed dilatation of the upper third of the aqueduct measuring 0.7 cm. in diameter. The lower third of the aqueduct in this patient was normal in size. Planigraphic studies of this patient showed a discontinuity of the aqueduct in its midportion suggesting that pressure against this structure exerted by the tumor displaced it laterally and dorsally, narrowing the middle segment both by pressure and torsion. The dorsal curve of the iter in these 2 cases was more pronounced than one might expect with a pontine tumor. Measurements from the middle of the aqueduct to the posterior clinoids in these 2 were 4.9 cm. and 5.1 cm. as compared with the normal measurement of 3.9 cm. In 2 patients the iter was neither displaced nor changed in contour. In the sixth patient the iter could be seen in the midline in the frontal views but could not be identified in the lateral views.

The fourth ventricle was well visualized in 5 patients. In 3 the measurements from the floor to the dorsum sellae was increased, and in 2 this was normal. The greatest displacement measured 5.6 cm., while the 2 considered normal were 3.5 and 3.6 cm. respectively. The depth of the fourth ventricle as measured from the fastigium to the base was normal in 2 and diminished in 3. The distance from the fastigium to the lowermost part of the posterior fossa were normal in 2 and elevated in 3. The floor of the fourth ventricle was relatively flat in 4 cases and concave in one. The angle formed by the floor of the fourth ventricle and a line drawn continuing the hard palate was 90 degrees in 2 and somewhat obtuse in the other 3.

The depth of the cisterna pontis was diminished in 2 patients, at the lower limit of normal in 2 and normal in 1. The cisternae magna and interpeduncularis, seen in 3 patients, were normal. In 1 patient the ipsilateral cisterna ambiens was not filled. The cisterna pontis was seen in 5 patients. It was normal in depth in 1, at the lower limit of normal in 2 and definitely decreased in 2.

CASE REPORTS

Case 1. R. R. (Hosp. No. 312460), a female, housewife, aged forty-five complained of nausea, dizziness and left-sided headaches for three months before admission. These had been insidious in onset, and had increased in frequency. The headaches were sharp and pounding. There were occasional episodes of left-sided weakness and a tendency to drop objects. The headaches radiated to the frontal region and posteriorly. There was no vomiting. Anosmia had been present for several years; the exact duration of this was unknown.

Physical examination revealed deafness of the right ear, left lateral nystagmus and bilateral left hemianopsia. There was a tendency to fall towards the left when walking, and a positive Romberg sign towards the left was present. The corneal reflex was decreased on the left side. The optic disc edges were blurred.

The cerebrospinal fluid proteins were elevated to 365 mg. per 100 cc.

Plain roentgenograms of the skull showed no bone changes. The sella turcica was normal in size, configuration and bone density. Ventriculographic examination revealed dilatation of both lateral ventricles with no displacement from the midline. The third ventricle was dilated but not displaced. The aqueduct of Sylvius and the fourth ventricle were normal. The

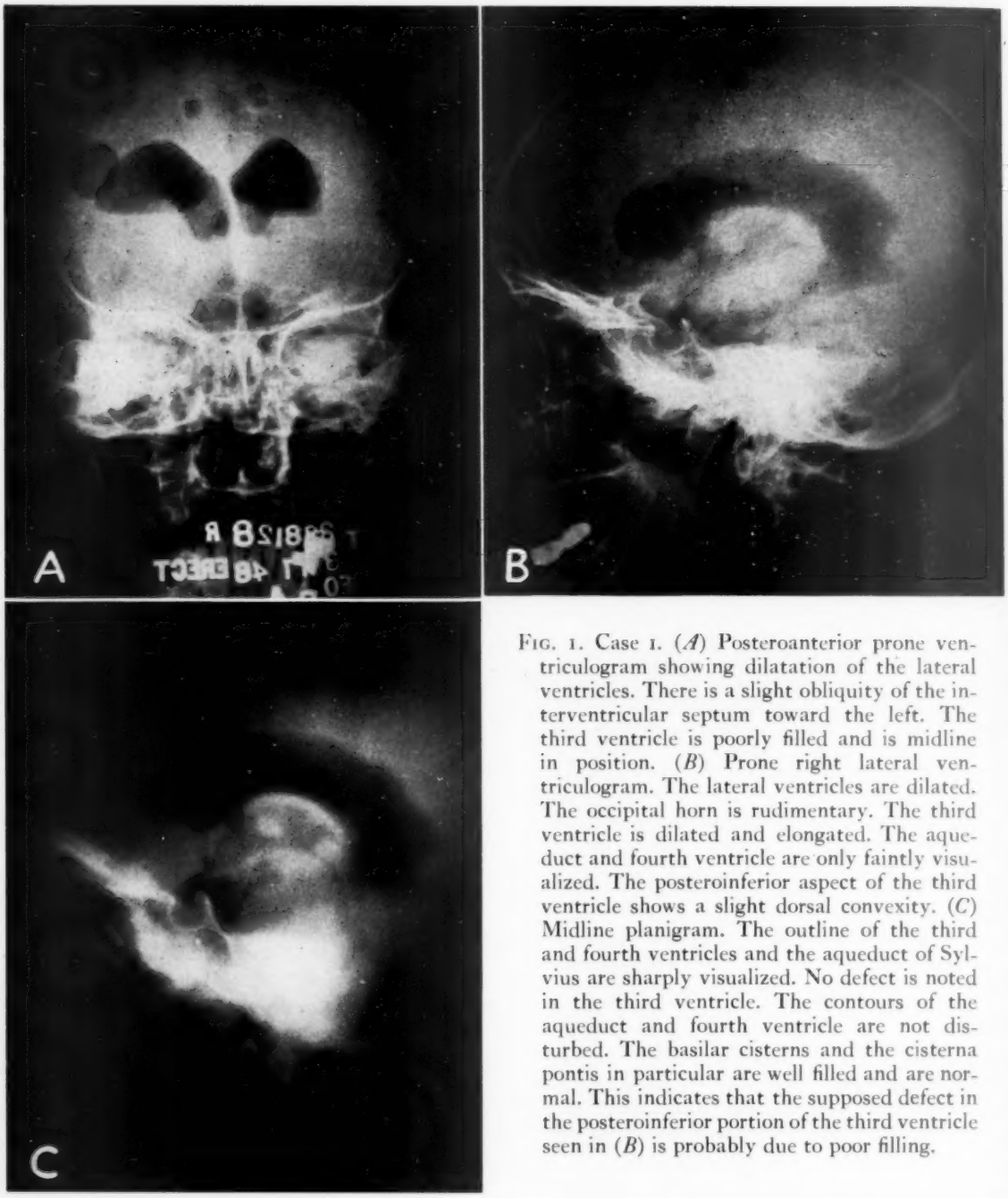

Fig. 1. Case 1. (*A*) Posteroanterior prone ventriculogram showing dilatation of the lateral ventricles. There is a slight obliquity of the interventricular septum toward the left. The third ventricle is poorly filled and is midline in position. (*B*) Prone right lateral ventriculogram. The lateral ventricles are dilated. The occipital horn is rudimentary. The third ventricle is dilated and elongated. The aqueduct and fourth ventricle are only faintly visualized. The posteroinferior aspect of the third ventricle shows a slight dorsal convexity. (*C*) Midline planigram. The outline of the third and fourth ventricles and the aqueduct of Sylvius are sharply visualized. No defect is noted in the third ventricle. The contours of the aqueduct and fourth ventricle are not disturbed. The basilar cisterns and the cisterna pontis in particular are well filled and are normal. This indicates that the supposed defect in the posteroinferior portion of the third ventricle seen in (*B*) is probably due to poor filling.

basilar cisterns showed no change from the normal.

The clinical diagnosis was an expanding posterior fossa lesion, probably a cerebellopontine angle tumor.

At operation the cerebellum was retracted and an encapsulated tumor was found in the left cerebellopontine angle. The tumor was incised and large chunks of yellowish tissue characteristic of perineurial fibroblastoma was removed. The tumor compressed the ninth, tenth and eleventh cranial nerves and its capsule was adherent to these nerves. The internal auditory meatus appeared to be slightly enlarged. The tumor was removed completely, including the capsule, and the patient made an

excellent recovery. Histopathologic examination of the tissue revealed perineurial fibroblastoma.

Comment. So far as could be seen on the pneumoencephalograms there was no visible interruption in the cerebrospinal fluid passages. Nevertheless, the lateral and third ventricles were quite dilated. Probably the pressure exerted by this tumor was against the lowermost portion of the fourth ventricle as it passes into the spinal canal, accounting for the hydrocephalus without distortion of the ventricular system.

Case II. B. S. (Hosp. No. 296281), a female, housewife, aged sixty-five, noted memory defects and inability to concentrate for about two weeks. Weakness in the right lower extremity appeared then. For about a year prior to admission she had had intermittent headaches which increased in intensity.

Physical examination disclosed an obese, well developed and nourished woman in no distress although she was quite negativistic in her response. The right corneal reflex was slightly

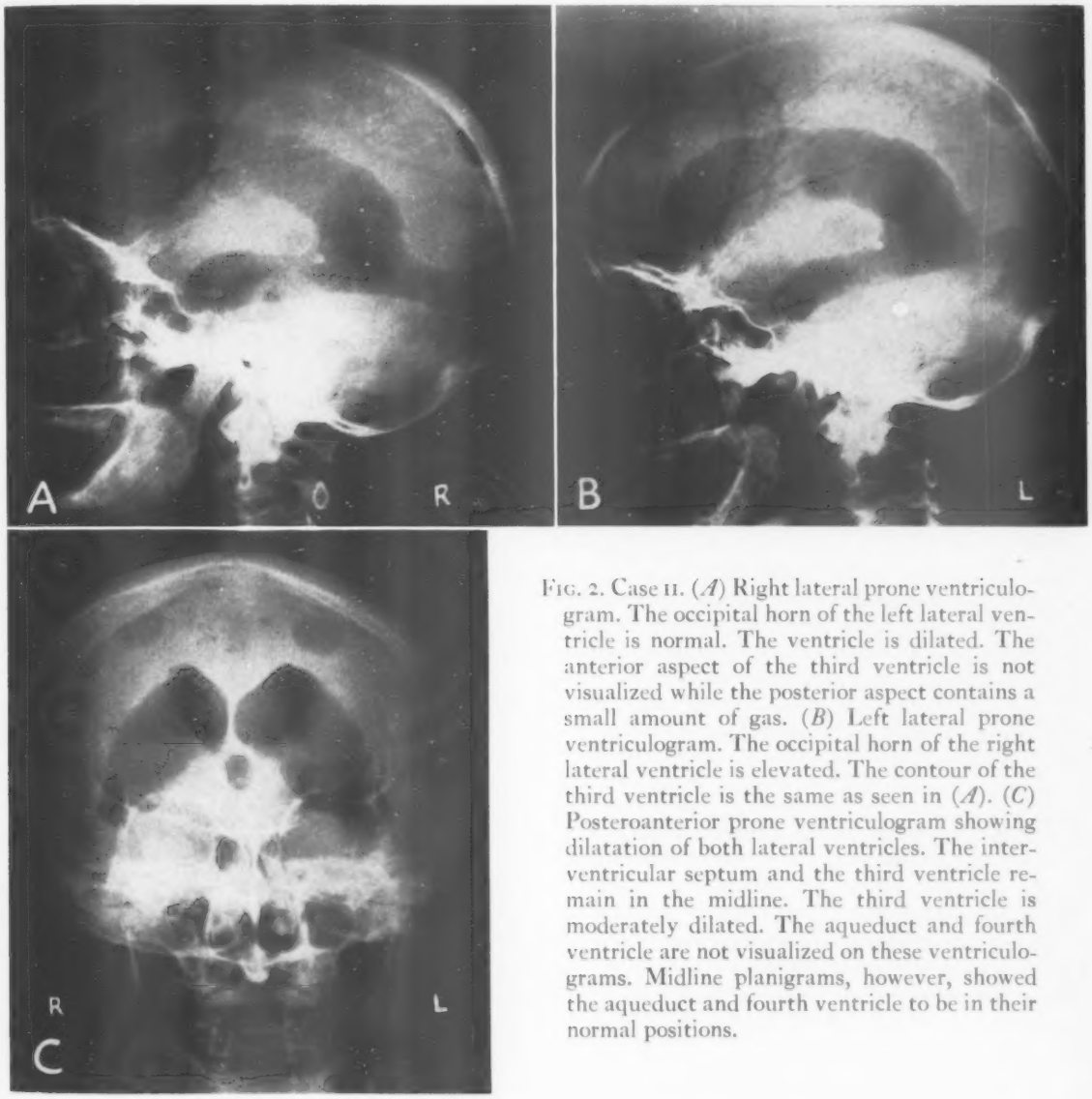

Fig. 2. Case II. (*A*) Right lateral prone ventriculogram. The occipital horn of the left lateral ventricle is normal. The ventricle is dilated. The anterior aspect of the third ventricle is not visualized while the posterior aspect contains a small amount of gas. (*B*) Left lateral prone ventriculogram. The occipital horn of the right lateral ventricle is elevated. The contour of the third ventricle is the same as seen in (*A*). (*C*) Posteroanterior prone ventriculogram showing dilatation of both lateral ventricles. The interventricular septum and the third ventricle remain in the midline. The third ventricle is moderately dilated. The aqueduct and fourth ventricle are not visualized on these ventriculograms. Midline planigrams, however, showed the aqueduct and fourth ventricle to be in their normal positions.

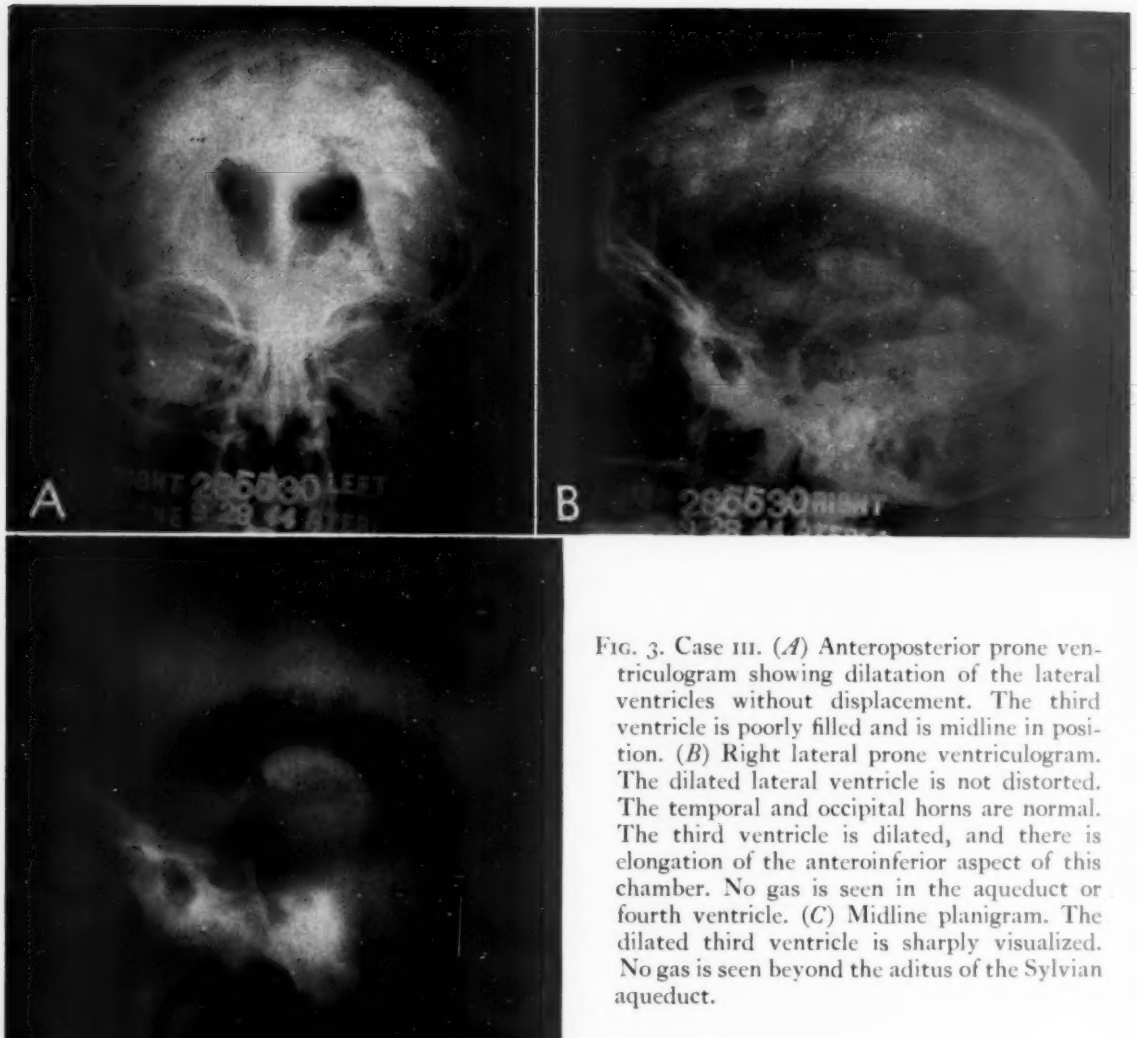

Fig. 3. Case III. (*A*) Anteroposterior prone ventriculogram showing dilatation of the lateral ventricles without displacement. The third ventricle is poorly filled and is midline in position. (*B*) Right lateral prone ventriculogram. The dilated lateral ventricle is not distorted. The temporal and occipital horns are normal. The third ventricle is dilated, and there is elongation of the anteroinferior aspect of this chamber. No gas is seen in the aqueduct or fourth ventricle. (*C*) Midline planigram. The dilated third ventricle is sharply visualized. No gas is seen beyond the aditus of the Sylvian aqueduct.

less active than the left. The left ankle jerk was absent. No ataxia or hearing loss was noted and the caloric responses were normal.

Cerebrospinal fluid examination revealed normal manometric responses. The protein content was elevated to 247 mg. per 100 cc., with four plus Pandy and globulin reactions.

Plain roentgenograms of the skull were negative. Ventriculographic examination revealed dilatation of the lateral ventricles with no displacement from the midline. The anterior aspect of the third ventricle was not filled, while its posterior portion and the fourth ventricle were well seen in their normal positions.

The patient became progressively more confused and drowsy. Surgical exploration of the posterior fossa showed the cerebellum to be relaxed. The cisterna magna appeared to be distended. Exploration of both angles showed no evidence of tumor.

During the next two months she became progressively more confused and drowsy. Reexamination revealed bilateral papilledema, nystagmus with the fast component to the left on left midlateral gaze, complete loss of vestibular action by cold water test, diminished right corneal reflex and generalized hyperreflexia. A review of her pneumoencephalograms disclosed elevation of the right occipital horn, previously overlooked.

She was re-explored and a right cerebello-

pontine angle tumor was found. The mass was about 4 cm. in diameter and was situated between the points of emergence of the facial and trigeminal nerves and apparently was attached to the eighth nerve. It was intimately attached to the cerebellum and the brain stem. The tumor capsule was opened and its yellowish content removed with a curette. Histopathologic examination showed perineurial fibroblastoma. She died twelve days later. Necropsy permission was refused.

Comment. In this instance there was neither obstruction nor displacement of the midline cerebrospinal fluid passages. The dilatation of the ventricular system and elevation of the ipsilateral occipital horn was indicative of a posterior fossa lesion. The poor filling of the anterior aspect of the third ventricle was confusing, but because there obviously was no interference in the flow of cerebrospinal fluid in this region the finding was considered unimportant.

Case III. U. S. (Hosp. No. 304372), a male, aged fifty-six, was admitted because of difficulty in walking. He had had poor hearing in his left ear for about ten years. There was no dizziness, headache, vomiting or impairment of vision.

Physical examination showed the patient to walk with a broad base. A left peripheral facial palsy was present together with diminution of the left corneal reflex. Cerebellar tests showed slight ataxia on finger-to-nose and heel-to-knee tests with slight dysdiadokokinesia. There was no response to caloric tests on the left.

Lumbar puncture showed normal manometrics. The protein content was elevated to 220 mg. per 100 cc.

Plain roentgenograms of the skull were negative. Ventriculography revealed pronounced dilatation of the lateral ventricles without displacement. The third ventricle was moderately enlarged and its posterior aspect and the aqueduct of Sylvius were displaced sharply from left to right. The fourth ventricle was displaced to the right by 2.5 cm., and dorsally so that the floor to dorsum measurement was increased to 5. 6 cm. The cisterna pontis was narrowed.

Operation revealed a smooth encapsulated tumor which on section presented a yellowish rather waxy appearance. Inferiorly the capsule was adherent to the ninth, tenth and eleventh cranial nerves and superiorly it was adherent to the fifth nerve. Medially it was adherent to the cerebellum and laterally to the rim of the acoustic meatus. Microscopic examination showed perineurial fibroblastoma. The patient made an excellent recovery.

Comment. The pronounced dorsal displacement of the lateral ventricle and contralateral deviation of the third ventricle and aqueduct of Sylvius immediately indicated the location of the tumor. The dilatation of the superior aspect of the aqueduct of Sylvius together with its absence of filling beneath until its union with the fourth ventricle is best seen on the planigrams. It is probable that here there was also an element of torsion changing the caliber of the iter in addition to the other displacements described.

Case IV. S. B. (Hosp. No. 277061), a female, aged thirty-two, had had a left central facial paralysis since the age of five years. The left corner of her mouth extended much higher than the right. She was unable to close her left eye and could not wrinkle her forehead. There were no other complaints or illnesses until four years before admission, when she first noted that she became totally deaf for periods of a few seconds. For one year she had had severe headaches and noises in both ears, with occasional episodes of staggering.

Physical examination showed hyperreflexia of the right lower extremity with a positive Babinski response. The abdominal reflexes were absent except for the right upper reflex. Adiadokokinesis of the left hand and pastpointing in the finger-to-nose test were present. Bilateral papilledema and coarse bilateral nystagmus were present. The left corneal reflex was absent and a left peripheral motor paresis existed. There was deafness in both ears and bone conduction was greater with air conduction abolished. Both ear drums were perforated.

Cerebrospinal fluid examination showed the total protein content to be normal. Plain roentgenograms of the skull showed no bone changes. Ventriculograms showed moderate dilatation of the lateral ventricles without displacement. The third ventricle was dilated and in the midline. No air went beyond the aditus of the sylvian aqueduct.

Operation revealed considerable bulging of

the cerebellum after the bone flap was turned. A large encapsulated tumor containing yellowish tissue was encountered. The tumor appeared to be in contiguity with the pons and cerebellum, but was not fixed to these structures. A complete removal was accomplished but the patient died forty-four days later. Histopathologic examination showed perineurial fibroblastoma.

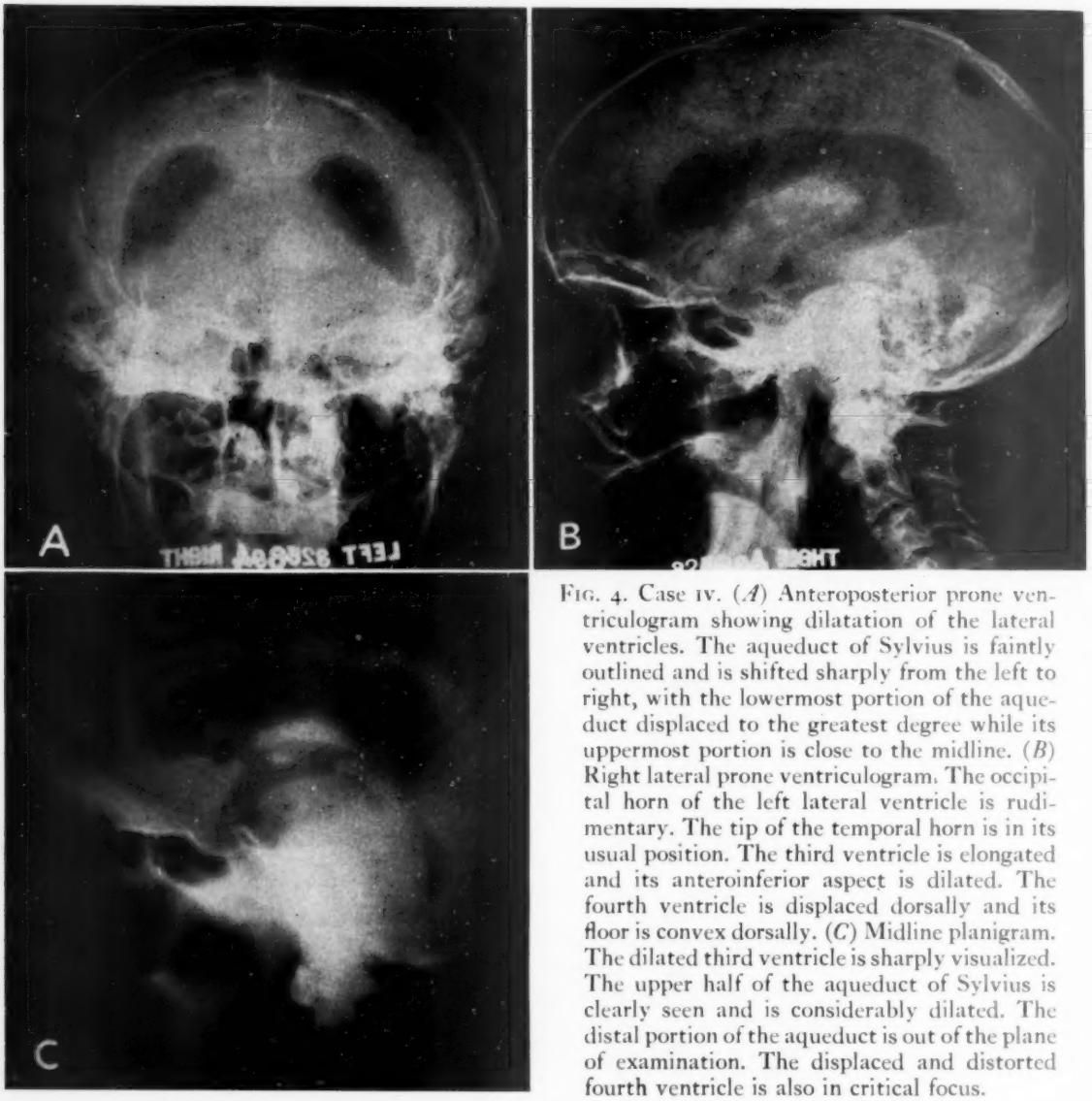

Fig. 4. Case iv. (*A*) Anteroposterior prone ventriculogram showing dilatation of the lateral ventricles. The aqueduct of Sylvius is faintly outlined and is shifted sharply from the left to right, with the lowermost portion of the aqueduct displaced to the greatest degree while its uppermost portion is close to the midline. (*B*) Right lateral prone ventriculogram. The occipital horn of the left lateral ventricle is rudimentary. The tip of the temporal horn is in its usual position. The third ventricle is elongated and its anteroinferior aspect is dilated. The fourth ventricle is displaced dorsally and its floor is convex dorsally. (*C*) Midline planigram. The dilated third ventricle is sharply visualized. The upper half of the aqueduct of Sylvius is clearly seen and is considerably dilated. The distal portion of the aqueduct is out of the plane of examination. The displaced and distorted fourth ventricle is also in critical focus.

Comment. The obstruction of the aqueduct of Sylvius obviously was not due to the tumor itself, but rather reflected changes in the posterior fossa due to the acoustic neuroma. Since autopsy permission was refused, we can but guess that the cerebellar edema was sufficient to cause aqueduct block.

DISCUSSION

The bone changes on plain roentgenograms of the skull are due to the pressure effect of the tumor on the auditory canal and adjacent petrous bones. If the principal growth of an acoustic neuroma occurs outside the auditory canal there may be no visible roentgenographic alterations.

The findings on pneumoencephalographic

examination, however, depend upon the changes in the posterior fossa arising from the tumor mass. If these are minimal, pneumoencephalography may disclose only slight or moderate hydrocephalus with neither distortion nor displacement of the midline cerebrospinal fluid passages. This may occur when the effect of the tumor is to diminish the circulatory passages either at the aqueduct of Sylvius or at the outlet of the fourth ventricle. When the tumor mass extends laterally and upward there is more likely to be pressure against the aqueduct and posterior aspect of the third ventricle, while with tumors which further encroach downward toward the foramen magnum variations in the configuration and position of the fourth ventricle may occur. These changes are due not only to the physical presence of the mass but equally important are the secondary effects such as cerebellar edema and extension of the tumor to adjacent structures. It is also quite likely that a torsion effect is produced causing rotary pressure effects on the aqueduct and fourth ventricle. Herniations of the brain stem upward through the incisura tentorii and of the cerebellum downwards through the foramen magnum have been reported.

SUMMARY

Plain roentgenograms of the skull in patients suspected of acoustic neuromas are best taken in Towne's projection and by demonstrating the petrous tips through the orbits. Positive information may be anticipated in about 30 per cent of these cases. Displacement of the pineal body and roentgenologic evidence of increased intracranial pressure are infrequent. Erosion of the ipsilateral posterior clinoid process was observed in two patients in Towne's view.

Pneumoencephalographic changes as noted in the present series and reported by others are as follows:

1. Dilatation of the lateral ventricles without displacement is frequent. Elevation and distortion of the ipsilateral temporal or occipital horns, and indentations into the atrium may occur but are relatively infrequent.

2. Dilatation of the third ventricle, with elongation of the base of the third ventricle, as seen in lateral views, is frequent. Contralateral displacement of the third ventricle may occur. Impressions into the posteroinferior aspect of the third ventricle by upward protrusion of the brain stem through the incisura tentorii has been described.

3. Dorsal and contralateral displacements of the sylvian aqueduct of varying degree occur relatively often. Complete block of the aqueduct at its uppermost portion may occur. Dilatation of the aqueduct may occur in its upper aspect if the tumor impinges on the lowermost segment of this structure. Rotation of the aqueduct with diminution of its caliber may occur because of torsion.

4. The fourth ventricle may be displaced laterally, dorsad, and may be rotated upon itself. Its floor may remain flat or may present some convexity dorsally. The chamber may be tilted dorsally. Its lumen may be compressed, and the fastigium displaced.

5. The cisterna pontis may be narrowed, but occasionally may remain normal. The cisterna ambiens on the ipsilateral side may be obliterated occasionally. The cisterna magna may be encroached upon, or may be impinged upon by downward protrusion of the cerebellar tonsils.

6. In some cases there may be neither displacement nor change in position or contour of the midline cerebrospinal fluid passages.

1398 Union St.
Brooklyn 13, N. Y.

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Vol. 64, No. 2

CHARCOT JOINTS SECONDARY TO DIABETES MELLITUS

By LEWIS COZEN, M.D.
LOS ANGELES, CALIFORNIA

CHARCOT first described joint changes associated with diseases of the central nervous system. At first it was considered that these changes occurred only in tabes dorsalis and syringomyelia, but it has been seen in other conditions. Leprosy or an injury to a peripheral nerve, as described by Weinberg, may produce these changes. Diabetes mellitus may cause similar lesions of bone.

This report deals with 2 cases of neuropathic foot lesions attributable to diabetes mellitus. The infection and osteomyelitis which were present do not change the neurologic aspect of the cases.

CASE REPORTS*

CASE 1. D. S., male, aged fifty-six, was first admitted in 1946 because of a swollen right foot. He had had diabetes mellitus for the previous seven years but refused to abide by any medical regimen as he was a Christian Scientist. He had noted a vesicle on the right little toe three days before admission. The day of admission he had a chill and the following day an abscess ruptured. The swelling diminished but did not disappear. During the course of this episode, the patient had little pain but there was slight "soreness." The blood sugar was 253 on the day of his admission. Treatment consisted of 30 units of insulin daily and 20,000 units of penicillin every three hours. A heat cradle was applied to the foot. When he was discharged at the end of two months, his blood sugar was under control and there was only

FIG. 1. Roentgenograms of Case 1.

* These patients were seen on the diabetic service of Dr. Sam Goodman and the orthopedic service of Dr. Paul McMaster.

slight swelling of the foot. He returned to the hospital on June 28, 1947, one year after the first admission, complaining of swelling of the entire right foot. No pain whatever was present now. Roentgenograms now showed distinctive changes. Vibration sense, position sense, and ankle reflexes were all diminished or absent. Deep pain sense-testicular was absent. Some drainage of pus occurred during his hospital stay. Treatment was similar to that on the first admission. He was discharged after two months; the drainage had ceased and the swelling had again diminished. Spinal puncture disclosed a negative Wassermann reaction and normal colloidal gold curve. Blood Kline test was negative on two occasions.

Fig. 2. Photograph of the right foot Case I.

Case II. S. K., male, aged twenty-six, was admitted on June 1, 1945, complaining of some swelling of the left foot. He had been a diabetic since 1939. Two months before admission he first noted a small ulcer in the region of the fifth metatarsal that started after a callus. He was treated by penicillin, 30,000 units every three hours, and a short leg cast was applied on the foot. He was placed on a diabetic diet and received 15 units of protamine insulin daily. When the cast was removed after three months there was no drainage, swelling, or fever. Examination revealed normal pupillary reflexes, absence of the Achilles tendon and patellar reflexes. The swelling of his foot was painless. When the cast was removed there was rigidity of the subastragaloid joint. Spinal puncture revealed a negative Wassermann reaction and normal colloidal gold curve.

Fig. 3. Roentgenogram of Case II.

Comment. In both these cases the infection and osteomyelitis obscured the picture of neuropathic joint that was present. According to Bailey and Root, the earliest gross change in a diabetic Charcot joint is a thickening of the tarsal region. The swelling is painless, there is no redness of the skin, heat, or other signs of inflammation. These changes progress slowly and usually result in a thickened deformed foot.

In roentgenologic appearance the changes are similar to the chronic neuro-

pathic joint of syphilis. Characteristically there is fragmentation and destruction of the metatarsal and tarsal bones. The joint spaces disappear.

In 2 cases from the series of 17 patients of Bailey and Root, in which amputation was done, histologic sections showed complete loss of bone structure, numerous spicules of bone scattered throughout the involved area undergoing varying stages of absorption and periosteum attempting to form new bone. These changes were partly obscured by secondary infection. The changes were thus like that in a Charcot joint being both destructive and proliferative. Examination of the peripheral nerves disclosed no definite abnormality. Increased vascularity and mild degenerative changes of all joint elements were seen.

Did these 2 patients have syphilitic Charcot joints? I do not think so. Key reported 70 patients with Charcot joints caused by syphilis. In each of these the diagnosis of neurosyphilis was made by physical and laboratory examination. Syphilitic Charcot joints rarely affect the foot, whereas diabetic Charcot joints occur in the foot as it did in these 2 patients.

Certainly there was insufficient circulatory damage to cause the changes which were present in the 2 patients cited. If only osteomyelitis were present, pain would be an important feature of the clinical syndrome.

Many diabetics were seen with disturbances of the extremities. If the bone or joint is affected it is assumed that this disorder is because of circulatory insufficiency as a result of diabetic arteriosclerotic peripheral vascular disease. It is probable that some of these patients have a diabetic neuritis that results in a neuropathic joint.

2007 Wilshire Blvd.
Los Angeles 5, Calif.

Fig. 4. Photograph of the left foot of Case 11.

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THE TOXICITY OF ROENTGEN RAYS TO THE CHICK EMBRYO*†

By DAVID A. KARNOFSKY, PRISCILLA A. PATTERSON, *and* LOIS P. RIDGWAY
Division of Experimental Chemotherapy, Sloan-Kettering Institute for Cancer Research
NEW YORK, NEW YORK

IN 1904 it was first reported that roentgen rays were toxic to the chick embryo, retarding their growth and producing abnormalities in development.[4,16] In the subsequent forty-five years, numerous publications have confirmed and elaborated on these findings.[1,2,3,5,10,14,15] This literature is complicated and difficult to interpret in many instances because of varied dosage techniques and incomplete biological observations. Consequently, in the course of our studies on the influence of various chemicals and roentgen rays on the growth of mouse tumors explanted to the chorioallantoic membrane of the chick embryo,[8] it was necessary to obtain adequate data on the toxicity of roentgen rays. Several unexpected findings resulted, which led to a general exploration of the problem.

MATERIALS AND METHODS

White Leghorn eggs were obtained from a commercial source. The eggs were incubated at 38° C. and a relative humidity of 75 per cent. While it was theoretically proper to maintain the eggs in an incubator at 38° C. during irradiation, such a procedure did not seem compatable with our need for a simple routine method for the irradiation of chick embryos. The eggs were therefore irradiated in a warmed room at a temperature of about 25–30° C. They were removed from the incubator just before irradiation, and then returned immediately after each exposure.

The roentgen-ray apparatus operated at 180 kv., 25 ma., and two opposing tubes were available, if needed. The filter was 0.5 mm. Cu and 1.65 mm. Al, giving a half-value layer of 0.8 mm. Cu. Usually, the eggs were irradiated at a target distance of 36 cm. at a dose rate of 43.4 r per minute but, in order to produce different dose rates, the target distances were varied. Batches of 6 to 9 eggs were exposed at one time in a tight-fitting cardboard box. Backscatter material was not used. The box was well within the field so that a fairly uniform dosage was obtained. The absorption of roentgen rays by the egg shell is negligible.[2] Measurements of the dose were made with a Victoreen ionization chamber in a presdwood phantom simulating the experimental set-up. The roentgens per minute as given in the text is at the estimated position of the embryo.

The roentgen rays were administered continuously or intermittently. The continuous exposure is reported as *total dose* (dose rate per minute) e.g., 1,200 r (43.4 r/minute). The intermittent exposure periods were generally equally spaced, and they are reported as *total dose* (total dose per exposure (dose rate/minute) ×number of exposures), the over all treatment period in minutes and the average dose rate per minute over this period, e.g., 1,200 r (300 r (43.4 r/minute) ×4), 1,200 minutes, 1 r/minute. The intermittent exposure method makes it technically possible to deliver a low over-all average dose without the time-consuming, and often impractical, continuous exposure technique.

The eggs were candled daily for viability, and the dead embryos were weighed and examined for gross abnormalities. Occasionally, an irradiated embryo was sacrificed in order to obtain a fresh specimen. Our facilities for hatching were inadequate, and although a few irradiated embryos hatched, hatchability rates should not be calculated from our data. It is important to note, however, that some irradiated embryos were capable of hatching. A total of more than 1,000 eggs was used for this study.

The LD_{50} of roentgen rays, administered in various fashions to embryos of different ages, were estimated from a graph of the pertinent

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data. These data were suitable for a qualitative assessment of the situation, but they were not subjected to a statistical analysis.

RESULTS

Groups of chick embryos were irradiated at two, three, four, five, six, seven, eight, nine, ten, twelve, thirteen and sixteen days of age. Our preliminary data made it apparent that two types of lethal effects were occurring, which required separate analysis. One type was designated as *acute death*, the embryo dying within twenty hours, but usually much earlier after irradiation, and the other as *delayed death*, usually occurring within ten days after irradiation.

A. Acute Death. The LD_{50} for *acute deaths* were determined in chick embryos from two to sixteen days of age by continuous exposure to a dose rate of 43.4 r/minute. The data are summarized in Table 1, and the estimated *acute* LD_{50} *doses* for the embryos of different ages are shown in Figure 1.

TABLE I

TOXICITY OF ROENTGEN RAYS TO CHICK EMBRYO IRRADIATED AT DIFFERENT AGES, DOSE RATE 43.4 r/MINUTE

Age, Days	Total Dose roentgens	No. Eggs	Acute Deaths	Embryo Deaths and Sacrifices ( ) Age Embryo, Days																	Per Cent Mortality*	No. Hatched / No. Surviving to Hatching
				3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	
2	600	6	0	0	(1)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2/5
	900	12	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	8.3	2/10
	1,200–1,350	22	0	0	1(2)	1(1)	2	1	0	1(1)	0	0	1	1	1	(2)	0	1	0	0	0	44.0	0/6
	2,000	13	1	(6)	(2)	1(1)	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.0	0
3	1,350	9	0		0	1	3	0	0	0	1	0	1	0	0	1	0	0	0	0	0	66.7	0/2
	2,000	9	3		(4)	0	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.00	0
4	1,200	10	2			0	1	1	0	1	1	1	0	1	0	(2)	–	–	–	–	–	75.0	0
	1,500	11	2			2(1)	1(1)	1	2	0	0	1	–	–	–	–	–	–	–	–	–	100.0	0
	2,000	12	12			–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100.0	0
5	1,000	5	0				0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0/5
	1,200	15	1				0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	7.2	0/13
	1,500–1,600	15	10				0	0	0	1	1	0	2	1	–	–	–	–	–	–	–	100.0	0
6	800	6	0					0	0	0	1	0	0	0	0	0	0	0	0	0	0	16.7	0/5
	1,200	15	5					0	0	0	0	0	2	1	0	(3)	1	0	0	0	0	40.0	0/3
	1,350	6	3					0	1	0	0	1	0	0	0	0	0	0	0	0	0	66.7	0/1
	1,500	7	6					0	0	0	0	1	–	–	–	–	–	–	–	–	–	100.0	0
7	800	6	0						0	0	0	0	0	0	0	1	0	0	0	0	0	16.7	0/5
	1,200	6	5						0	0	0	0	1	–	–	–	–	–	–	–	–	100.0	0
8	700	14	7							0	0	0	0	0	0	0	0	0	0	1(2)	0	0	1/4
	900	6	6							–	–	–	–	–	–	–	–	–	–	–	–	–	–
9	700	5	3								0	0	0	0	0	0	0	0	0	0	0	0	1/2
	800	5	4								0	0	0	0	0	0	0	0	0	0	0	0	1/1
13	500	10	0												0	0	0	0	0	0	(5)	0	0
	600	10	0												0	0	0	0	0	0	(10)	0	0
	700	20	11												0	0	0	0	0	0	(9)	0	0
16	600	5	0															0	0	0	0	0	5/5
	700	5	0															0	0	0	0	0	1/5
	800	6	2															0	0	0	0	0	0/4

* Ten day survival period after irradiation or to hatching (excluding acute deaths).

B. Delayed Death and Effect of Dose Rate. Embryos surviving the *acute* effects of irradiation often succumbed to its *delayed* effects, usually within ten days. At a dose

rate of 43.4 r/minute, young embryos (two to six days of age) were relatively resistant to the *acute* effect of roentgen rays, and it was possible to administer a sufficiently large dose (1,200–1,500 r) to produce *delayed death*. In older embryos, 43.4 r/minute produced *acute deaths* in the range of 800 r, a dose insufficient to cause *delayed deaths*. The *acute toxicity* of roentgen rays in the older chick embryo thus seriously limited the production of *delayed* radiation effects.

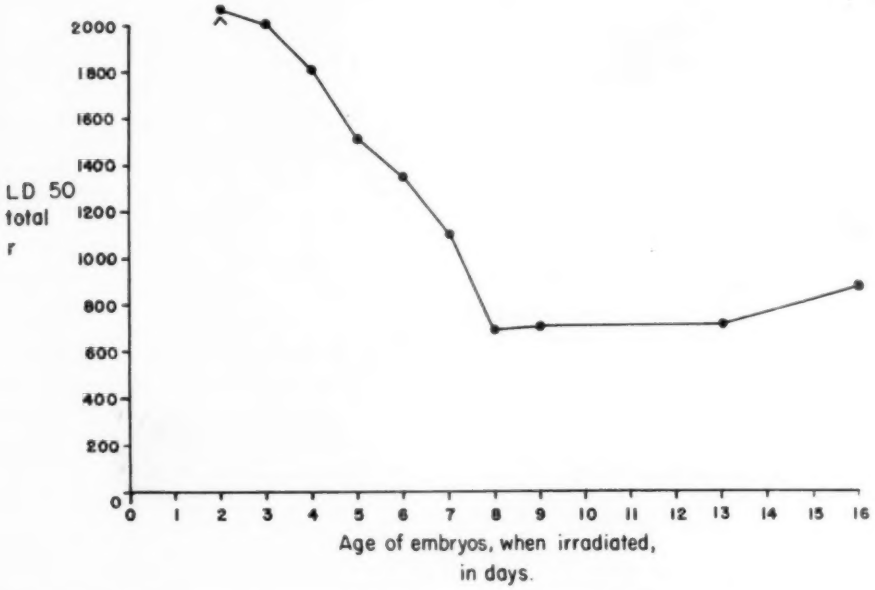

FIG. 1. Approximate LD_{50} dose of roentgen rays to produce *acute deaths* in chick embryos of different ages. Dose rate, 43.4 r/min. (see Table 1).

It was therefore necessary to find out how to deliver large doses of roentgen rays to the eight day and older chick embryos without eliciting the *acute* toxicity. It was soon noted that the *acute* toxic effect of roentgen rays was related critically to the dose rate. By dropping the dose rate below the critical level the *acute* effect was avoided, larger total amounts of roentgen rays could be given, and *delayed deaths* were produced.

In exploring the relationship between the *acute* and *delayed* toxic effects of roentgen rays on the chick embryo, the following four points were considered.

1. The comparability of intermittent and continuous irradiation. It is not generally feasible to expose chick embryos to continuous low dose rates of roentgen rays for long periods. This technique puts a severe demand on time and equipment, and for long exposure periods the embryos should certainly be kept at 38° C. Fortunately, there is good evidence, providing the dosage fractionation is adequate, that the effects of roentgen rays are comparable whether administered continuously or intermittently at a higher dose rate, so that the average dose rate for the over-all period of treatment is the same.[11,12,13] Our experimental results, while they do not represent an adequate assessment of this relationship, are consonant with those of Paterson and Thompson[13] and Lea.[11] The comparability in the effects of continuous and intermittent irradiation applies to both the production of *acute* and *delayed* toxicity.

In the case of *acute toxicity*, for example, the critical dose rate to produce 50 per cent *acute deaths* in the twelve day embryo at 800 r is about 10 r/minute. The administration of this dose, either continuously or fractionated so that the average dose rate over the over-all exposure period is 10

TABLE II

THE TOXIC EFFECTS OF ROENTGEN RAYS ADMINISTERED INTERMITTENTLY AT VARIOUS AVERAGE OVER-ALL DOSE RATES TO CHICK EMBRYOS OF DIFFERENT AGES

(Each line represents a separate experiment)

Total Dose (roentgens)	Dosage Fractions (roentgens)	Dose Rate (roentgens)	Over-all Experimental Period (minutes)	Estimated Over-all Dose Rate (roentgens)	No. Embryos	Acute Toxicity	Embryo Deaths and Sacrifices ( ) Age embryo, days														Per Cent* Mortality	No. Hatching / No. Surviving to Hatching
							7	8	9	10	11	12	13	14	15	16	17	18	19	20		
							5 day embryos															
600	300×2	43.4	100	6.0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		3/6
900	300×3	43.4	150	6.0	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	16.7	2/5
1,200	300×4	43.4	200	6.0	6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0/5
1,500	300×5	43.4	250	6.0	6	0	0	1	0	0	0	1	0	1	2	0	0	0	0	0	83.3	0/1
							6 day embryos															
1,500	300×5	43.4	291	5.2	6	0		0	0	0	1	0	0	0	1	1	0	0	0	0	50.0	0/3
							8 day embryos															
800	200×4	43.4	75	10.7	6	3				0	0	0	0	0	0	0	0	0	0	0	0	1/3
900	300×3	43.4	250	3.6	6	2				0	0	0	0	0	0	0	0	0	0	0	0	1/4
	300×3	43.4	150	6.0	6	0				0	0	0	0	0	0	0	0	0	0	0	0	1/6
1,000	200×5	43.4	120	8.2	7	7				–	–	–	–	–	–	–	–	–	–	–	–	–
1,200	300×4	43.4	230	5.2	6	5				1	–	–	–	–	–	–	–	–	–	–	100.0	–
	300×4	43.4	200	6.0	6	1				1	0	0	0	0	0	0	0	0	1	1	20.0	0/2
	200×6	43.4	172	7.0	7	6				0	0	0	1	–	–	–	–	–	–	–	100.0	–
1,500	300×5	43.4	1,500	1.0	40	4				(36) used for another experiment											–	–
	300×5	43.4	450	3.3	40	3				(31)	0	0	0	1	0	1	(4)	–	–	–	–	–
	300×5	43.4	250	6.0	6	3				0	0	0	0	1	0	0	1	0	0	0	66.7	0/1
	300×5	43.4	215	7.0	6	5				0	0	0	0	1	–	–	–	–	–	–	100.0	–
1,800	300×6	43.4	300	6.0	6	5				0	0	0	0	1	–	–	–	–	–	–	100.0	–
							9 day embryos															
900	300×3	43.4	135	6.7	12	10					0	0	1	0	0	(1)	–	–	–	–	–	–
1,200	300×4	43.4	270	4.4	30	19					1	0	0	0	2	0	0	(8)	–	–	–	–
	300×4	43.4	200	6.0	12	12					–	–	–	–	–	–	–	–	–	–	–	–
1,500	300×5	43.4	250	6.0	37	37					–	–	–	–	–	–	–	–	–	–	–	–
							10 day embryos															
1,200	300×4	43.4	300	3.6	12	11						0	0	0	0	0	0	0	0	0	0	0/1
1,500	300×5	43.4	410	3.7	12	10						1	0	1	–	–	–	–	–	–	100.0	0
1,800	300×6	43.4	500	3.6	12	10						0	0	0	0	1	0	0	0	0	50	0/1
							12–13 day embryos															
660	200×3	50.0	192	3.4	6	0								0	0	0	0	0	0	0	0	0/6
720	300×2	50.0	74	9.7	6	1								0	0	0	0	0	0	0	0	0/5
800	200×4	43.4	44	18.0	6	6								–	–	–	–	–	–	–	–	–
	200×4	43.4	65	12.0	6	5								0	0	0	0	0	0	0	0	1/1
	200×4	43.4	98	8.0	6	1								0	0	0	0	0	0	0	0	2/5
	200×4	43.4	150	5.3	5	0								0	0	0	0	0	0	0	0	3/6
880	200×4	50.0	256	3.4	6	0								0	0	0	0	0	0	0	0	0/6
900	300×3	43.4	191	4.7	10	0								0	0	0	0	0	1	(9)	–	–
	300×3	43.4	100	9.0	6	3								0	0	0	0	0	0	0	0	0/3
1,000	500×2	43.4	120	8.0	10	1								0	0	0	0	0	0	2(7)	22.0	–
	200×5	43.4	124	8.0	12	5								0	0	0	0	0	0	1	9.0	0/6
1,080	300×3	50.0	140	7.7	6	3								0	(3)	–	–	–	–	–	–	–
1,200	300×4	43.4	330	3.6	12	0								1	0	0	0	0	0	1	16.7	1/10
	300×4	43.4	275	4.3	10	1								0	0	0	0	0	0	(9)	–	–
	300×4	43.4	230	5.2	6	4								0	0	0	0	0	0	0	0	0/2
	300×4	43.4	230	5.2	6	1								0	0	0	0	0	0	0	0	0/5
1,320	220×6	50.0	380	3.4	6	0								1	0	1	0	0	0	0	33	0/4
1,440	360×4	50.0	208	6.9	6	3								0	3	–	–	–	–	–	100.0	–
1,500	300×5	43.4	417	3.6	12	0								0	0	0	0	1	0	0	8.3	0/11
	300×5	43.4	370	4.0	12	2								0	0	0	0	1	0	(9)	–	–
	300×5	43.4	290	5.2	6	3								0	0	0	0	0	0	0	0	0/3
	300×5	43.4	290	5.2	6	0								0	0	1	0	0	0	0	16.7	0/5
	300×5	50.0	270	5.5	6	3								0	0	2(1)	–	–	–	–	–	–
	300×5	50.0	270	5.5	12	0								6	(6)	–	–	–	–	–	–	–
1,800	300×6	43.4	500	3.6	12	0								1	0	2	0	1	0	1	41.7	0/7
	300×6	43.4	350	5.1	6	1								0	1	0	0	0	0	0	20.0	0/4
	300×6	43.4	350	5.1	6	0								1	1	0	0	1	0	0	33.3	0/4
2,400	300×8	50.0	460	5.2	6	0								0	3	1(2)	–	–	–	–	–	–
							16 day embryos															
1,800	300×6	43.4	360	5.0	12	0												1	2	0	25.0	1/9

* Ten day survival period (excluding acute deaths).

r/minute (within the limits of our data) may be expected to give the same results.

The *delayed toxicity* is much more directly related to the total dose administered. At a total dose of 1,200 r, which produces a delayed lethal effect in the five day old chick embryo, approximately the same results may be expected from the continuous and intermittent administration of roentgen rays, provided the over-all dose rate is in the same range. We have not observed, in our limited data on the chick embryo, a significant difference in the *delayed* toxic effects of 1,200 to 1,500

r, when administered at 6 or 43.4 r/minute.

2. The critical dose rate in relation to the production of acute deaths in chick embryos of different ages. By the use of the intermittent dosage technique, the critical dose rates producing or avoiding *acute deaths* were examined for embryos of different ages. The problem is a complicated one because of the individual variation in the response of the embryos to irradiation, and the variations in dosage technique that must be considered. The accumulated data from experiments extending over a two year period are presented in Table II. It is seen that the LD_{50} for the *acute* lethal dose of roentgen rays is about 700 to 800 r at a dose rate of 6 to 10 r/minute for the 8 day and older embryos, and there is a suggestion that the critical dose rate is even lower, in the range of 3–6 r/minute, for eight to ten day embryos. In Figure 2 we have graphically presented the maximal dose rates which may be expected to produce fewer than 50 per cent *acute deaths* in embryos receiving a total of 1,200 to 1,500 r. This graph is based on the data contained in Tables I and II, and only the points on the graph are based on the experimental data.

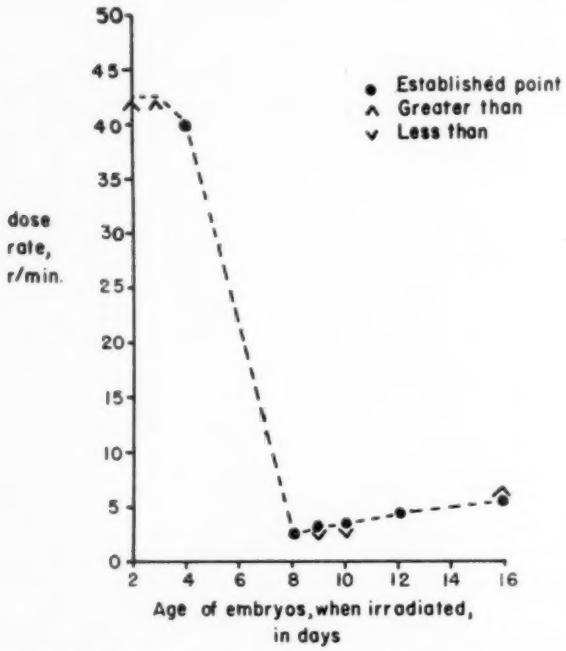

FIG. 2. For a total dose of 1,200 to 1,500 r this chart shows the estimated over-all maximum dose rate in r/min. (continuous or intermittent) which may be expected to produce fewer than 50 per cent *acute deaths*.

3. The approximate delayed LD_{50} dose of roentgen rays for chick embryos of different ages. With a proper regard to the important factor of dose rate, it is possible to deliver a sufficient total dose of roentgen rays to produce delayed effects in the chick embryo at all stages of development. Since the delayed effects of roentgen rays, whether given at 43.4 r/minute continuously, or intermittently for an over-all dose rate of 3.6 to 6.0 r/minute, are believed to be practically comparable, the *delayed toxicity* of roentgen rays to chick embryos may be estimated from the data in Tables I and II. Embryo deaths occurring within ten days after irradiation were used as a basis for estimating toxicity; a ten day observation is obviously impossible for embryos irradiated at twelve, thirteen and sixteen days of age.

In chick embryos from two to seven days of age, the LD_{50} for *delayed deaths* is in the range of 1,000 to 1,200 r at a dose rate of 43.4 r/minute. In the eight to thirteen day old embryos, at an over-all average dose rate of 3 to 6 r/minute (and higher in some cases), the LD_{50} for an eight to ten day observation period is in the range of 1,200 to 1,500 r. The limited toxicity data available on embryos irradiated at different ages make more quantitative estimations unprofitable. Several embryos hatched after receiving a dose of 800 to 900 r, and one embryo receiving 1,200 r on the twelfth day of incubation hatched, but died five days later.

4. The effect of low over-all dose rates on the chick embryo. Eight and nine day old chick embryos were irradiated at low over-all dose rates of 0.27 to 0.83 r/minute and total doses of 600 to 1,600 r. As shown in Table III, these low dose rates will produce some toxic effects on the chick embryo, but they seem to be less severe than those produced by similar total doses given at 3 to 4 r/minute. It is evident, however, that the maximum dose rate of roentgen rays toler-

ated indefinitely by the chick embryo will be less than 0.5 r/minute (administered intermittently to give an over-all average dose rate).

C. Morphological Changes Induced by Roentgen Rays. The morphological changes produced in chick embryos by roentgen rays have been described in the past,[1,2,4,5,10,16] and it is only necessary to summarize briefly our experiences. The total dose of roentgen rays (at dose rates greater than 1 r/minute) that consistently produced conspicuous damage to the chick embryo and *delayed deaths* in embryos irradiated at two to thirteen days of age, was in the range of 1,000 to 1,500 r. The principal gross changes occurring in the embryos differed somewhat with the age of the embryos when irradiated, and they may be classified as: (1) vascular injury, (2) embryo edema, (3) stunting in body growth, (4) developmental abnormalities and (5) alterations in the appearance of the liver and spleen.

Vascular injury: The allantoic vessels of the embryos irradiated at two to four days became tenuous and pale, and frequently the embryo was judged by candling to be dead. Sometimes hemorrhages were seen. In most cases, if incubation was continued, the embryo recovered, and within two to three days the blood vessels of the allantois were restored to normal appearance. In older embryos, the early injury to the chorioallantoic membrane was not as evident. Embryos irradiated at four to six days and surviving for one week or longer often seemed pale, and embryos irradiated at eight to twelve days may die within a week with generalized petechiae and hemorrhages in the viscera and yolk sac. While the evidence of vascular injury roughly varied with the age at irradiation, there was considerable overlapping in these effects. The action of roentgen rays on hematopoiesis was not examined.

Embryo edema: Within two to five days after irradiation, a most frequent finding was the appearance of a generalized edema, apparently associated with the subsequent death of the embryo. In the younger embryos the edema was generally of a watery, translucent and, sometimes, slightly milky appearance, whereas in the older embryos there was a tendency toward a more gelatinous exudate. The edema was seen most prominently four to seven days after the irradiation of eight day old embryos. Its presence was often associated with some degree of stunting in the growth of the embryo, and necrotic patches in the liver. Embryos surviving to hatching rarely showed this effect.

Stunting in body growth: Embryos surviving for several days after irradiation generally showed proportional growth, although some developmental abnormalities did occur, which will be noted later. Irradiation, however, produced a general depression in growth which appeared to be inversely related to the age of the embryo at the time of irradiation. In other words,

TABLE III

THE TOXICITY OF ROENTGEN RAYS ADMINISTERED AT LOW AVERAGE OVER-ALL DOSE RATES TO THE EIGHT AND NINE DAY OLD CHICK EMBRYO

Total Dose	Dosage Fractionation	Dose Rate	Over-all Exposure Period, Hours	Estimated Over-all Dose Rate	No. Embryos	Embryo Deaths and Sacrifices ( ) Age Embryo, Days													Per Cent Mortality	No. Hatched No. Surviving to Hatching
						9	10	11	12	13	14	15	16	17	18	19	20	21		
		8 day embryos																		
600 r	300 r×2	43.4 r	24	0.42 r	10	1	0	0	0	0	0	0	0	0	0	0	0	0	10	8/9
900 r	300 r×3	43.4 r	48	0.31 r	10		1	0	0	0	0	0	0	0	0	0	0	0	10	5/9
1,200 r	300 r×4	43.4 r	72	0.27 r	10				0	0	0	0	0	0	0	(5)	0	0	0	1/5
1,500 r	300 r×5	43.4 r	96	0.26 r	10					0	0	0	0	0	0	(5)	0	0	0	0/5
		9 day embryos																		
1,600 r	400 r×4	43.4 r	49	0.55 r	8		1	0	1	0	0	1	0	0	1	0	2	0	71	0/2
1,600 r	400 r×4	43.4 r	32	0.83 r	8		0	1	0	0	0	0	0	0	1	0	1	0	38	0/5

embryos temporarily surviving a total dose of 1,200 to 1,500 r continued to show a growth rate only slightly less than normal. For example, the embryos irradiated at two to four days of age may show almost the same enormous increase in mass occurring in the untreated controls, so that ten to twelve days later they may only weigh about 20 per cent less than the controls. On the other hand, embryos irradiated at twelve days of age may be proportionately more severely stunted when compared six to eight days later with untreated controls of the same age. The observation of Jacobson *et al.*[6] that the bone marrow of the rabbit, rendered hyperplastic by phenylhydrazine, a hemolytic agent, is more resistant to roentgen rays, may have a similar basis. Certainly, the relationship of growth activity and tissue recovery rate to the degree of growth inhibition induced by roentgen rays is a problem of great interest.

Developmental abnormalities: We have not catalogued the developmental abnormalities which occurred in irradiated embryos, but certain common defects have been noted in passing. These are as follows: beak deformities (failure of the lower beak to develop properly, or crossed beak), eye defects (absence of an eye or asymmetry, and cysts over the cornea), disproportionately small heads, and limb abnormalities (thin legs and deformed or absent toes). The feather pattern may be abnormal, but it is of interest that they may develop after 1,500 to 1,800 r. The head feathers seem to be somewhat less affected than the body feathers by roentgen rays. The major abnormalities appeared in embryos irradiated at eight days of age or earlier, and were conspicuous at twelve to eighteen days of incubation. It was rare for a deformed embryo to survive to hatching.

Liver and spleen: A whitish edge was frequently seen in the liver of the irradiated embryo, due to necrosis of the liver cells. This was often associated with embryo edema and death. The spleens of embryos irradiated at twelve days and surviving to hatching were markedly reduced in size, whereas the spleens of the embryos irradiated with a similar total dose at two to four days and surviving to hatching were of almost normal size.

DISCUSSION

The chief points we wish to discuss in this report are the *acute* and *delayed toxicity* of roentgen rays. The *acute* effects of roentgen rays on the chick embryo have apparently not been appreciated in the past, although they are implicit in the work of Strangeways and Fell[15] and Lea,[11] and in the review of Spear.[14] Strangeways and Fell, for example, wrote in 1928:[15]

> The first question to be decided was why the tissues of the irradiated 6 day and (with one exception) 17 day embryos died after 24 hours incubation whilst the tissues of 20–25 hour embryos, which in some cases had been simultaneously irradiated with 6 day specimens, underwent a partial recovery 24 hours subsequent to irradiation.

They suggest two possible explanations: (1) that younger tissues are more resistant, and (2) older embryos are more complicated and roentgen rays induce a physiological disturbance.

Lea's data[11] will be cited in some detail because, although interpreted differently, they seem to be in general agreement with our own. Lea's radiation equipment was a 160 kv. machine with its filter having a half-value layer of 1 mm. of copper. The eggs were irradiated after six days of incubation and then opened two or three days later and their viability recorded. The LD_{50} of roentgen rays for the chick embryos under these conditions were determined at different intensities of radiation (150, 28.6, 7.7 and 2.88 r/minute), and we have summarized his data, with an estimation of the LD_{50} at the various dose rates, as shown in the table at the top of the next page.

Lea concludes, from these data, that the effects of roentgen rays are practically independent of intensity above 10 r/minute, whereas by dropping the dose rate to lower levels, either by continuous or intermittent dosage, the amount of roentgen rays tolerated by the embryo is greatly increased. Lea interprets his data as indicat-

SUMMARY OF LEA'S DATA[11]

Total dose, r	150 r/min.	28.6 r/min.	7.7 r/min.	2.88 r/min.
	Per Cent Mortality at 2–3 Days			
400		0	10	
600	20	10		
700		60		0
750	0		10	
820	70			0
1,020	100		20	
1,200			100	10
1,500				10
1,900				35
Est. LD_{50} 2–3 day survival	750 r	800 r	1,150 r	>2,000 r

ing, in theory, that the chick embryo can tolerate a dose rate of 2.5 r/minute indefinitely.

Although Lea's results of the six day old chick embryo compare more closely with our eight day embryo data, we believe that he has lumped together *acute* and *delayed deaths* in his toxicity study. At the dose rates of 28.6 and 150 r/minute, it is likely that the embryos were killed by the *acute* effect of irradiation. The deaths occurring at 7.7 r/minute at the total dose of 1,200 r are probably also *acute* deaths. When the dose rate was dropped to 2.88 r/minute, the *acute* toxicity was avoided, and 65 per cent of the embryos were alive two to three days following 1,900 r. It is probable, if the observation period had been prolonged, that these embryos would have subsequently succumbed to the *delayed* effects of roentgen rays.

Several suggestions concerning the acute toxic effect of roentgen rays appear from our data. Young embryos are not highly susceptible to the *acute* effects, they develop their maximum sensitivity about the eighth to tenth day of incubation, and their sensitivity is established at a slightly higher dose rate on the twelfth day and beyond. These toxicity data may possibly be correlated with a hypothetical system in the embryo, which develops during the fourth to seventh day of incubation, is complete at the eighth day and achieves its adult level at the twelfth day. The "system" is one which recovers very rapidly from an almost *acute* lethal dose of roentgen rays, and the damage to this "system" does not appear to be appreciably cumulative at subcritical dose rates. The nature of this system remains to be determined. The suggestion that the *acute* effect occurs in the egg because, being a closed system, it cannot get rid of toxic substances following irradiation, is rendered unlikely by the fact that roentgen rays produce a similar type of acute death in young chicks.[7] In order to check on the specificity of this reaction, we attempted to produce *acute deaths* in mouse embryos by irradiating an eighteen day pregnant mouse with a total of 5,000 r at 200 r/minute; the mother and fetuses, however, were alive when sacrificed forty-eight hours later. The *acute* toxicity of roentgen rays in the chick embryo appears to be a unique phenomenon, and it would seem of great interest to elucidate its nature.

The *delayed* effects of roentgen rays on the chick embryo must be carefully distinguished from the *acute* effects. Our data indicate that the LD_{50} of roentgen rays for the two to twelve day embryo is relatively constant, and in the range of 1,000 to 1,500 r. This dose range includes chick embryos receiving roentgen rays by continuous irradiation at 43.4 r/minute, and by intermittent exposure to produce an over-all dose rate of 1 to 6 r/minute. Our data suggest roentgen rays given at a dose rate of 0.5 r/minute, while producing significant tissue injury to the chick embryo, is less effective than the same total dose given at 5.0 r/minute. Essenberg,[2] using a dose rate of 36 r/minute, has obtained lethal effects in chick embryos, irradiated at nineteen to twenty-three hours of incubation in the range of 400 to 500 r. The reasons for the discrepancies in results are not clear, but a satisfactory comparison of the data does not seem possible.

It is of incidental interest that roentgen rays, one of the most potent inhibitors of growth, are not nearly as effective as the

4-amino pteroylglutamic acid derivatives (anti-folics) in suppressing the growth of the four day old chick embryo.[9] This may be due to the fact that the action of roentgen rays is immediate and tissue recovery occurs in the surviving embryos, whereas the 4-amino PGA compounds, when introduced into the egg, act continuously on the growing cells.

SUMMARY

Roentgen rays have been found to exert both an *acute* and *delayed* toxic effect on the chick embryo. The *acute* effect results in death of the embryo within twenty hours after irradiation. In embryos, eight days and older, the *acute* toxic effect is dependent on a dose rate above 5 to 10 r/minute, and is relatively independent of a total dose above 800 r. The embryo shows an increasing sensitivity to this acute effect during the third to seventh day of incubation, it is most sensitive at the eighth to tenth day, and its response is stabilized at a slightly more resistant level on the twelfth day and beyond. The *acute* death may be avoided, and *delayed* deaths produced, by lowering the dose rate appropriately for the age of the embryo at the time of irradiation.

The *delayed* effects of roentgen rays are cumulative, and the LD_{50} for chick embryos of two to twelve days of age is in the range of 1,000 to 1,500 r, at dose rates varying from 1 to 43.4 r. The effects of roentgen rays are still cumulative to produce *delayed* deaths at a dose rate of 0.55 r/minute. The embryos succumbing to the *delayed* lethal effect of roentgen rays may show vascular injury and hemorrhage, generalized edema, consisting of either a watery or gelatinous fluid, necrosis of the liver and stunting in growth. Developmental abnormalities are common, and are chiefly evident in the beak, limbs, head and eyes.

Sloan-Kettering Institute
444 East 68th St.
New York 21, N. Y.

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THE TOXICITY AND PATHOLOGICAL EFFECTS OF ROENTGEN RAYS IN THE CHICKEN*†

By JOHN A. JACQUEZ *and* DAVID A. KARNOFSKY
Division of Experimental Chemotherapy, Sloan-Kettering Institute for Cancer Research
NEW YORK, NEW YORK

IN A previous paper[4] it was shown that *acute deaths* are induced in the eight to sixteen day old chick embryo by roentgen rays given at dose rates of 10 r per minute and above, and this effect is relatively independent of a total dose above 800 r. By reducing the dose rate below 10 r per minute the *acute deaths* were avoided, and roentgen rays could be administered in sufficient dosage to produce delayed lethal radiation effects in the embryo. Because of the interest in this observation, toxicity studies were also carried out on immature and mature chickens. Representative tissues were examined in some of the treated chickens for evidence of radiation injury.

MATERIALS AND METHODS

White Leghorn chickens, from three days to one year of age were obtained from a commercial source. They were maintained under appropriate conditions, either in a brooder or open pen. The roentgen rays were generated by a machine consisting of two opposing tubes operating at 180 kv. and 25 ma., and a filter giving a half-value layer of 0.8 mm. of copper. The target distance was varied from 15 to 53 cm. in order to permit variations in dose rate. Roentgen rays were applied either by continuous or intermittent exposure.[4]

The chickens were exposed in a cardboard box in groups or singly, depending on their size. The dose was calculated in air to the center of the target, and provision for backscatter was not made. The chickens were observed daily after irradiation, and 33 were autopsied following sacrifice or immediately after spontaneous death, and representative tissues were fixed in Zenker-formol, sectioned at 10μ and stained with hematoxylin and eosin for histological study. These tissues usually included the thymus, spleen, liver, bone marrow, and small intestine, and occasionally the thyroid, adrenal, ovary, esophagus, crop and trachea were examined.

RESULTS

A. Toxicity of Roentgen Rays to Young Chicks. The effects of roentgen rays in chicks from five days to ten weeks of age appeared to be consistent, so the results of all the experiments on chicks in this age range were pooled. Roentgen rays were found to cause *acute* and *delayed deaths* in these chicks at dosage relationships somewhat similar to those noted for chick embryos, although certain quantitative differences appeared.

Acute deaths. The results obtained from the continuous exposure of young chicks to roentgen rays at dose rates of 8 to 150 r/minute and to total doses of 600 to 10,000 r are summarized in Table I. At a dose rate of 43 r/minute and higher, it was estimated that a total dose of 960 r would produce *acute deaths* in 50 per cent of the chicks. The critical dose rate producing 50 per cent *acute deaths* at a total dose of 1,000 r or higher was estimated, from the data in Table I, as 10 r/minute. By treating the chicks intermittently, and then calculating the over-all average dose rate for the treatment period, the dose rate, producing 50 per cent *acute deaths* at total doses of 1,200 r, and higher, was estimated to be 11 r/minute (Table II), which is in good agreement with the 10 r/minute figure obtained by continuous irradiation.

Delayed deaths. Chicks surviving the *acute* effects of roentgen rays may succumb

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TABLE I

TOXICITY OF ROENTGEN RAYS, CONTINUOUS IRRADIATION, TO YOUNG CHICKS (5 DAYS TO 10 WEEKS OF AGE)

Line	Total Dose, r	Dose Rate r/min.	No. Chicks	Time of Death After Exposure: Acute Deaths, Hours 0–6	7–24	Delayed Deaths, Days 2	3	4	5	6	7	8	9	10	11	12	13	14	15	Per Cent Mortality Deaths: Acute*	Delayed†
1	10,000	110–150	5	5	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
2	5,000	110–150	4	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
3	2,500	150	2	1	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
4	2,000	80	6	2	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
5	1,350	80	4	0	4	–	–	–	–	–	–	–	–	–	–	–	–	–	–	100	–
6	1,200	43–50	21	17	3	1	–	–	–	–	–	–	–	–	–	–	–	–	–	95	100
7	1,200	12	4	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75	0
8	1,200	8	4	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	25	33
9	1,000	43	10	1	4	2	1	0	0	0	0	2	–	–	–	–	–	–	–	50	100
10	900	43–110	14	0	3	1	0	2	1	0	1	0	1	0	1	1	0	0	0	21	73
11	800	43	11	0	2	0	2	0	2	0	0	1	0	0	0	0	0	0	0	18	56
12	700–750	43–100	12	0	1	0	0	0	0	0	0	1	1	0	0	1	0	0	0	8	27
13	600	83–110	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	10

* The critical dose rate producing *acute* deaths in 50 per cent of the chicks was estimated in the chicks receiving a total dose of 1,200 r, lines 7 and 8.

† The delayed LD_{50} was estimated on the basis of per cent mortality in those chicks surviving the acute LD_{50}, lines 10, 11, 12 and 13.

to its *delayed* effects, usually within a period of three to twelve days after irradiation. The LD_{50} at a dose rate of 43.4 r/minute and higher was in the range of 800 r, on the basis of a fifteen day observation period (Table I). At lower dose rates, over the range of 0.28 to 10.5 r/minute, the LD_{50} appeared to be somewhat higher, in the range of 1,100 to 1,200 r (fifteen day observation period) (Table II). Considerable variation was found in the toxic effects of roentgen rays in the range of the LD_{50} dose, and a quantitative comparison of the delayed lethal effects of the roentgen rays when given at high and low dose rates cannot be made from our data.

It is apparent that while the *acute toxic effect* of roentgen rays was not cumulative

TABLE II

TOXICITY OF ROENTGEN RAYS TO YOUNG CHICKS (5 DAYS TO 10 WEEKS OF AGE), INTERMITTENT IRRADIATION

Line	Total Dose, r	Dosage Fractions r	Dose Rate r/min.	Over-all Exposure Period, min.	Estimated Over-all Dose Rate r/min.	No. Chicks	Time of Death After Exposure: Acute Deaths, Hours 0–6	7–24	Delayed Deaths, Days 2	3	4	5	6	7	8	9	10	11	12	13	13	15	Per Cent Mortality Deaths: Acute*	Delayed†
1	2,400	600×4	50	4,320	0.55	3	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0	100
2	1,800	600×3	50	2,880	0.63	8	0	0	0	1	2	1	1	1	2	0	0	0	0	0	0	0	0	100
3	1,500	300×5	50	250	6.0	9	0	0	0	0	0	2	3	2	0	0	0	0	0	0	0	0	0	71
4	1,200	300×4	50	54	22.2	4	3	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	100	—
5	1,200	300×4	50	85	14.2	4	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	67	0
6	1,200	300×4	50	96	12.5	3	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	67	100
7	1,200	300×4	50	114	10.5	4	1	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	25	67
8	1,200	300×4	43–50	158–231	5.2–7.6	30	0	0	0	0	1	0	2	6	2	0	1	0	0	0	0	1	0	43
9	1,200	300×4	50	445	2.7	4	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	75
10	1,200	600×2	50	1,440	0.83	6	0	1	0	0	0	1	1	1	2	0	0	0	0	0	0	0	17	100
11	1,200	300×4	50	4,320	0.28	3	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	67
12	1,000	200×5	43	192	5.2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	900	300×3	43	150	6.0	9	0	0	0	0	1	0	0	0	0	1	0	3	0	0	0	0	0	55
14	800	200×4	43	154	5.2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	600	200×3	43	86	7.0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

* The critical dose rate producing acute deaths in 50 per cent of the chicks was estimated from lines 5, 6, 7 and 8.

† The delayed LD_{50} was estimated on the basis of the per cent mortality in those chicks surviving the acute LD_{50}, lines 3, 5–15,

below the critical dose rate, the *delayed toxic effects* were cumulative, even at an over-all average dose rate as low as 0.28 r/minute.

B. Toxicity of Roentgen Rays to Four to Twelve Month Old Chickens. The *acute* and *delayed* toxicity of continuously administered roentgen rays at dose rates of 40–60 r/minute were examined in four to twelve month old hens and roosters. These data are summarized in Table III.

These results were not nearly as consistent as those obtained for chicks; thus, prostration and then death, which occurred in many instances within two to eight hours. Within two hours after irradiation the chickens appeared depressed and weak, they moved about with effort, and in the next few hours became prostrated, paralyzed, occasionally fluid oozed from their mouths and they often gasped and sometimes convulsed before death. At the minimal doses producing *acute* toxicity, chickens sometimes survived for twenty-four hours or longer and they showed severe, progressive prostration before

TABLE III

TOXICITY OF ROENTGEN RAYS TO 4 TO 12 MONTH OLD CHICKENS, CONTINUOUS IRRADIATION AT 40 TO 60 r PER MINUTE

Total Dose, r	No. Chickens	Mortality		Per Cent Mortality
		Acute deaths, within 24 hr.	Delayed deaths, days after exp.	
5,000	6	1	3, 3, 5, 6, 6	100
3,000	4	4	—	100
2,000	3	2	6	100
1,500	11	7	5, 6, 6, 6	100
1,250–1,350	3	2	4	100
900–1,000	3	0	2, 6, 8	100
600	2	1		50

a total dose of 5,000 r produced only 1/6 *acute deaths*, whereas 15/21 chickens succumbed *acutely* to total doses of 1,250 to 3,000 r. While some adult chickens were apparently resistant to the *acute* effects of roentgen rays, it was remarkable to find fewer *acute* deaths occurring in the chickens receiving the highest total dose. These variable responses of mature chickens could not be correlated with their age or sex.

Chickens usually died of the *delayed* effects of roentgen rays within two to eight days. The *delayed* LD_{50} was not clearly encompassed by our toxicity data, but it appears to be in the range of 600–800 r, a dose similar to that found for young chicks (Table 1).

C. Acute Deaths from Roentgen Rays. The typical picture of *acute* irradiation death in chickens consisted of depression, dying. It was possible that starvation and dehydration contributed to these prolonged *acute* deaths.

A total of 19 irradiated young and mature chickens were obtained for autopsy, either by sacrifice two to twenty hours after irradiation, when death seemed imminent, or immediately after death. Two chicks were sacrificed as controls. At autopsy the only abnormal findings were occasional petechiae in the thymus and some fluid in the trachea. The significant changes found in the tissues on microscopic examination were confined to the lymphatic system and liver.

The most striking change was the presence of a disseminated, focal, coagulative necrosis in the liver (Fig. 3, 4, 5), a lesion which has also been noted by Bloom.[1] In the advanced lesions cell membranes were

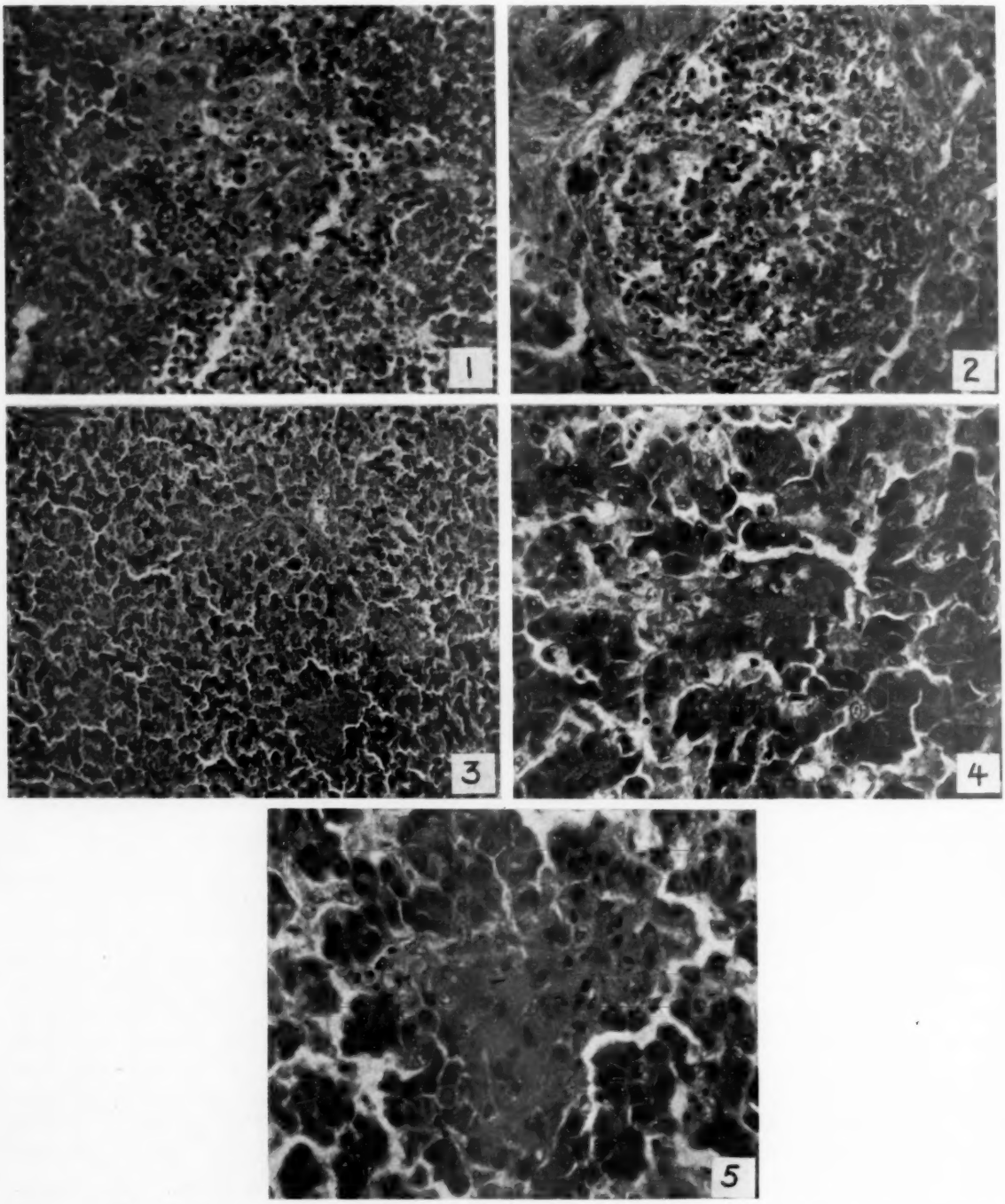

Fig. 1. Thymus of chick showing chromatin debris; 1,200 r, 46 r/min. *Acute death* in two hours. 460×.
Fig. 2. Lymph nodule in spleen of chick; 1,250 r, 46 r/min. *Acute death* in two hours. 460×.
Fig. 3. Focal necroses in liver of chick; 1,250 r, 46 r/min. *Acute death* in four and a half hours. 100×.
Fig. 4. Early focal necrosis in liver of chick; 1,200 r, 46 r/min. *Acute death* in two hours. 460×.
Fig. 5. Large focal necrosis in chick liver; 1,250 r, 46 r/min. *Acute death* in four and a half hours. 460×.

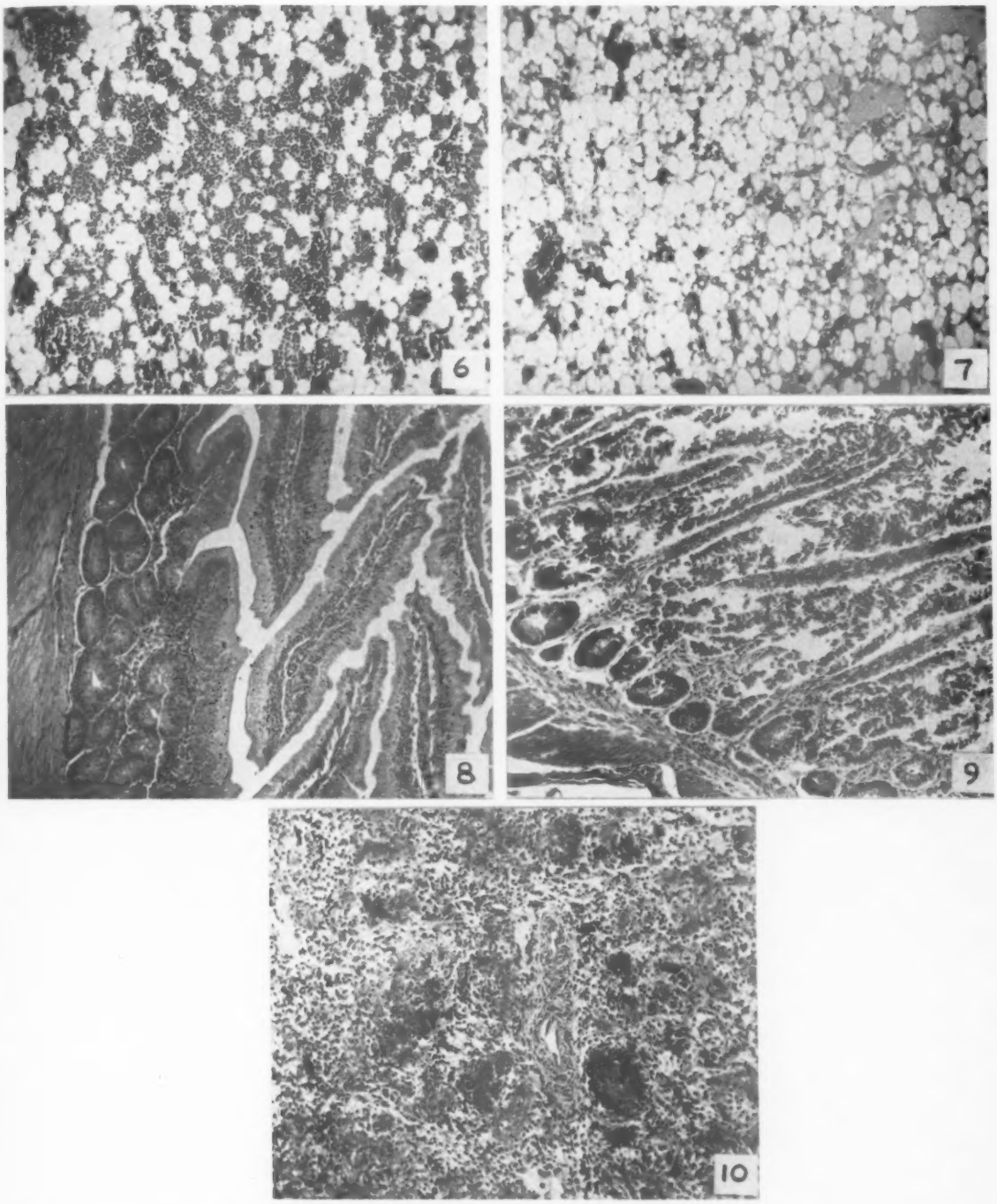

Fig. 6. Normal bone marrow from upper end of tibia. 100×.
Fig. 7. Bone marrow from upper end of tibia of hen that received 5,000 r at 46 r/min. Sacrificed on sixth day. 100×.
Fig. 8. Normal upper small intestine of chick. 100×.
Fig. 9. Upper small intestine of chick that received 600 r (46 r/min.) on two successive days. Died six days later. 100×.
Fig. 10. Bacterial colonies in spleen of chick that received 300 r (46 r/min.) on three successive days. Died four days later. 100×.

no longer visible, and the lesion consisted of a mass of coagulated cytoplasm containing nuclei in various stages of degeneration. These lesions cannot be confused with degenerative lymphocytic foci in the liver.

The *thymus*, *spleen* and the *lymph nodules* in the intestines, bone marrow, liver and bronchi showed marked changes within two hours after irradiation (Fig. 1 and 2). Cytolysis of the lymphocytes

TABLE IV

PATHOLOGICAL CHANGES OBSERVED IN IMMATURE AND ADULT CHICKENS TREATED WITH AN ACUTELY LETHAL DOSE OF ROENTGEN RAYS

Chick No.	Age Weeks	Total Dose, r	Dose Rate r/min.	Time of Death after Irradiation, Hours	Focal Liver Necrosis	Spleen	Thymus	Lymph Foci
						Pyknosis and Degeneration of Lymphocytes		
				1 to 4 week old chicks				
228	1	1,250	46.6	2	++	++++	+++	+++
1,390	2	1,200	46.6	4	+++			
1,393	2	1,200	46.6	4.5	+++			
299	1	1,250	46.6	4.5	+++	++++	+++	+++
231	1	1,250	46.6	5	++++	+++	+++	+++
1	1–2	1,200	46.6	5	++	++	++	++
213	3–4	1,200	46.6	5.5	++++			
3	1–2	2,500	46.6	6	+++	++	++	++
2	1–2	1,200	46.6	7	+++			
201	1	1,250	46.6	10	+++	+++	+++	+++
	Sex			4 to 12 month old chickens				
135	♀	1,500	54.5	4	+			
405	♂	1,500	54.5	5	+			
64	♂	1,500	54.5	6	+			
62	♂	1,500	54.5	6	+			
404	♀	1,500	54.5	6	+			
406	♂	1,350	46.6	8	++	++	++	++
136	♀	1,250	46.6	12	+++	++	++	++
407	♂	2,000	46.6	18	+++	++++	++++	+++
105	♀	1,500	46.6	20	++	++	++	++
Control 1–2		o	o	—	o	o	o	o
Control 1–2		o	o	—	o	o	o	o

o Normal.
+ Detectable.
++ Definite.
+++ Moderate.
++++ Very severe.
Blank space—tissue not examined.

The liver lesions were more severe and occurred more consistently in chicks (Table IV), and it may be significant that the clinical depression produced by the acute effects of roentgen rays was also more pronounced and predictable in the younger birds.

with pyknosis and fragmentation of nuclei were present. The reticuloendothelial cells showed little change, and the other components of the bone marrow appeared normal. No significant or consistent lesions were found in other tissues.

D. Delayed Deaths from Roentgen Rays.

Chickens surviving the *acute* effects of roentgen rays usually died of the *delayed* effects (Tables I, II, III). The lethally intoxicated chickens appeared to be in relatively good condition until just before death, three to ten days after irradiation. Some evidence of weight loss was present, and occasionally oral ulcerations appeared and blood was seen in the stool. The chickens seemed to show an increased tendency to bleed, which was particularly noticeable when blood was taken for counting. The histological changes present in the chickens dying of *delayed* radiation effects were distinctly different from those found in the chickens dying *acute* deaths. Our observations on 11 chickens of various ages, dying or sacrificed two to nine days after irradiation, are summarized in Table V.

TABLE V

PATHOLOGICAL CHANGES OBSERVED IN IMMATURE AND ADULT CHICKENS, 2 TO 9 DAYS AFTER IRRADIATION. DOSE RATE 46.6 r/MINUTE

Chick No.	Total Dose, r	Dosage Fractions r	Overall Exposure Period, Minutes	Estimated Over-all Dose Rate, r/min.	Time of Death, Days	Liver	Lymphatic Organs	Intestinal Epithelium	Bone Marrow	Lung
							1 to 4 week old chicks			
160	2,400	600×4	4,320	0.55	2	Bacterial colony	Shrunken, no lymphocytes	Marked necrosis	Severe hypoplasia	Slight fibrinous exudate
169	900	300×3	2,880	0.31	4	0	Shrunken, spleen full of bacteria	Marked necrosis	Severe hypoplasia	Slight fibrinous exudate
163	1,800	600×3	2,880	0.63	5	0	Shrunken, no lymphocytes	Marked necrosis	———	Slight fibrinous exudate
158	2,400	600×4	4,320	0.55	5	0	Shrunken, no lymphocytes	———	Severe hypoplasia	Slight fibrinous exudate
157	1,200	600×2	1,440	0.83	6	0	Shrunken, 1 large abscess in spleen	Marked necrosis	Severe hypoplasia	Slight fibrinous exudate
172	1,200	300×4	4,320	0.28	6	0	Shrunken, no lymphocytes	Slight necrosis	Few immature myeloid cells	0
174	1,200	300×4	4,320	0.28	7	0	Spleen full of bacterial colonies	Slight necrosis	Few immature myeloid cells	Few bacterial colonies walls lung
178	900	300×3	2,880	0.31	8	0	Shrunken, no lymphocytes	Necrosis	Few immature myeloid cels	Slight fibrinous exudate
							Mature hens			
104	1,500	—	—	46.6	5	Many bacterial colonies	Shrunken, few bact. col. spleen	Marked necrosis	Severe hypoplasia few bact. colonies	Many bacterial colonies
137	5,000	—	—	46.6	6	Fatty degen., 1 abscess	Shrunken, bact. colonies spleen	Marked necrosis	Severe hypoplasia	Few bacterial colonies
231	5,000	—	—	46.6	6*	—	Shrunken, no lymphocytes	Marked necrosis	Severe hypoplasia	Invasion thrombotic vessel by yeast-like organism

* Sacrificed.

The *thymus* and *spleen* were shrunken so that only the reticulum and connective tissue framework remained. Intact lymphocytes were difficult to find in these organs, and also in the lymphatic foci normally present in other organs.

The *bone marrow* was practically aplastic and consisted of dilated sinusoids and fat (see Fig. 6 and 7). The frequency of secondary infection in these birds may be due to their low resistance secondary to the aplastic condition of the marrow. In fact, the oral lesions present in some of the birds suggested the clinical picture of agranulocytosis in man. Bacterial colonies were found in the liver, spleen and lungs in several specimens, and the only reaction to these colonies was the formation of a dense, hyaline substance around them. A section of spleen containing these colonies is shown in Figure 10. In one case, the lung was in-

vaded by a mycotic organism.

The liver lesions seen in the chicks that died acutely were not found in the chicks dying of the delayed radiation effects. It was considered possible that the liver lesions appeared early after irradiation and then healed in the animals surviving the acute toxicity period. To examine this possibility, four to five day old chicks were given 1,200 r (46.6 r/minute, 300 r×4 over a 162 minute exposure period) to give an over-all average dose rate of 7.4 r/minute, a dose which would not be expected to produce *acute* death. The chicks were sacrificed four to five hours later, and their livers sectioned. Only one out of four livers showed the typical focal necrosis, a far lower incidence than that seen in young chicks dying of the *acute* effects of irradiation. It is therefore likely that the liver lesions are associated with the *acute* lethal effects of roentgen rays.

The *upper portion* of the *small intestine* showed marked damage to the epithelium with sloughing and secondary infection. The crypts often had a very flat epithelium with a considerable amount of debris in the center (Fig. 8 and 9). This damage was not as marked in the lower part of the intestine and cecum.

The *lungs* frequently showed a small amount of fibrinous exudate.

The *crops, esophagus, thyroid, kidney* and *adrenals* were examined in a few instances, but they appeared to be normal.

DISCUSSION

The chick responds to roentgen rays in a manner similar to that seen in the twelve day and older chick embryos. The critical dose rate which will produce 50 per cent acute deaths, relatively independent of a total dose above 1,000 r, or higher, is about 10 r/minute, as compared to 6–10 r/minute in the chick embryo.[4] Continuous irradiation or intermittent irradiation, so that the same over-all average dose rate is obtained, seems to have a similar activity. Mature chickens are also susceptible to the acute effects of roentgen rays, but the results were less consistent, and it seemed paradoxical that the greatest total dose gave the fewest acute deaths. It is considered possible that two systems exist in equilibrium in the adult chickens; when system A, the more sensitive one, is eliminated by roentgen rays, system B is uncontrolled and death results, whereas at higher doses, both systems are inactivated.

Prosser *et al.*[6] have noted that chickens and rabbits may occasionally succumb *acutely* to an LD_{50} dose of roentgen rays, but there has been no systematic exploration of this problem. It may be of interest that Webber and Steggerden[9] have observed the transient appearance of histamine in the blood of rats within two hours after irradiation, and this observation may offer a clue as to the nature of the acute death. Most of the work on roentgen-ray toxicity in animals, however, has shown than an enormous total dose, in the range of 10,000 to 25,000 r, is necessary to produce acute death. These large doses have been given to mice and rabbits by Henshaw[3] and to goldfish by Ellinger.[2] The consistent production of *acute* effects in the chick by relatively low doses of roentgen rays, and the relation of the *acute* toxicity to a critical dose rate therefore appears to be a special phenomenon.

The areas of liver necrosis occurring promptly in the chick after acutely lethal doses of radiation suggest that there may be some causal relationship. It was already noted that these areas did not appear consistently in young chicks receiving roentgen rays at dose rates just below those producing the *acute* effect, and in mature chickens treated at high dose rates. Bloom[1] has noted these liver lesions in chicks, but has questioned their relation to irradiation. Tsuzuki[7] described areas of necrosis in the livers of rabbits receiving total body irradiation, and noted that these lesions disappeared within thirty-six to forty-eight hours. It is possible, particularly since the rabbit may occasionally die acutely from relatively low total doses of roentgen rays, that these liver lesions are related to those occurring in the chick.

The lymphatic destruction which occurs

in the acutely intoxicated chickens is probably also present in the chicks irradiated at similar total doses, but at dose rates which do not produce acute deaths, since the birds succumbing to the *delayed* effects of irradiation show almost complete involution of the lymphatic system.

The nature of the mechanism which is so sensitive to a critical dose rate of roentgen rays, and how it is related to the acute, and presumably transient, liver lesions (in those chicks surviving) remains to be discovered. Further progress in understanding these acute effects of roentgen rays appears to be in the hands of the pharmacologist and biochemist.

The delayed LD_{50} (fifteen day observation period) of roentgen rays for chickens (700–800 r at 40 r/minute and probably higher, and 1,100–1,200 r at 0.28–10.5 r/minute [over-all average dosage rate by intermittent exposures]) may be slightly higher, but it is essentially in the same range as those reported for many mammals.[1,5,6,8] The LD_{50} of roentgen rays producing *delayed deaths* is apparently higher for the chick embryo than for the chick, and the greater resistance of the embryo may be partially due to the absence of infection in the egg. It is nevertheless of interest that the embryo appears to be less sensitive than the chick to the *delayed* toxic effects of roentgen rays.

SUMMARY

Acute deaths are produced by roentgen rays in young chicks at dose rates above 10 r/minute and total doses of 1,000 r, or higher. The *delayed* LD_{50} dose, in those chicks surviving the *acute effects* of high dose rates, is about 800 r, and at low dose rates it is about 1,100–1,200 r.

Adult chickens of both sexes may die acutely at total doses of 1,250–3,000 r, but they have often survived a dose of 5,000 r for several days. Chickens surviving the acute effects, succumb within three to ten days, and the LD_{50} is in the range of 600 to 800 r.

The chickens dying acutely following irradiation show, within two hours after irradiation, necrotic foci in their livers, and pyknosis and fragmentation of their lymphatic cells. The delayed deaths are not associated with liver injury, but the lymphatic tissues involute, including the thymus and spleen, the bone marrow becomes aplastic, erosions and degenerative changes occur in the intestinal tract, and there is frequent evidence of bacterial infections. These observations on the delayed effects of roentgen rays parallel those reported for mammals.

Sloan-Kettering Institute
444 East 68th St.
New York 21, N. Y.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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Thirty-Third Annual Meeting: Atlantic City, N. J., 1951.

EDITORIAL

RADIATION THERAPY OR SURGERY IN CANCER OF THE CERVIX UTERI

DURING the last decade the advent of newer cytologic methods of examination, increasing variety of antibiotics, more efficient antishock measures and greatly improved surgical techniques have created a demand for a re-evaluation of the best therapeutic approach in cancer of the cervix uteri. The problems of particular interest fall into three different categories: (1) significance and treatment of preclinical cancer of the cervix; (2) indications and extent of radical surgery in the operable group of cancer of the cervix; and (3) advisability of pelvic exenteration as a palliative procedure in the advanced group of cancers of the cervix. In considering these problems, it appears advisable to evaluate the scope of the new surgical approach in relation to the position of the presently accepted methods of radiation therapy.

(1) Preclinical cancer of the cervix is also called pre-invasive cancer, intra-epithelial cancer or cancer in situ. Its characteristics have been described in extenso by Galvin.[1] According to this very competent author the histopathologic concept of intra-epithelial carcinoma was introduced by Schottlaender and Kermauner as far back as 1908 and crystallized by Schiller in 1928, but it is only lately that its clinical concept has also acquired the importance it actually deserves. This is attributed to the divergence of opinion among various pathologists as to the borderline between an incipient carcinoma and various non-malignant cellular alterations, such as "basal cell hyperactivity" (Galvin), "simple atypical epithelium" (Hinselman, Wespi), etc., and especially to the fact that intra-epithelial carcinoma, owing to the asymptomatic state of the patient, is very difficult to detect.

Galvin, on the basis of 108 cases of intra-epithelial carcinoma studied at Johns Hopkins Hospital, states that all the evidence available supports the view that the lesion is the precursor of invasive cancer of the cervix. Its features are that it occurs in younger women, the average age in the group studied being 36.7 years as compared to forty-six years for invasive cancer of the cervix; that it progresses slowly, the longest period observed being twelve years; and that it displays no pathognomonic signs or symptoms.

According to various investigators the methods most apt to lead to diagnosis of preclinical cancer of the cervix include the Papanicolaou test, the Novak epithelial scraping and above all the multiple biopsy from at least four points of the cervix and cervical canal. However, as Galvin emphasizes, the secret of detecting the lesion must rest on the alertness of all those who first examine the patient, being conscious of the fact that any abnormal appearing cervix may harbor a latent incipient carcinoma.

There is considerable controversy as to the treatment of this lesion, whether one should resort to conservative surgical measures (conization, amputation, etc.), or perform total hysterectomy or use some form of radiation therapy, preferably intracavitary radium.

(2) The tendency to re-introduce radical surgical methods for the treatment of the operable group of cancer of the cervix

[1] Galvin, G. A. Diagnosis of cancer of cervix; early lesion. *Radiology*, June, 1950, *54*, 804–812.

arises from the fact that in a certain number of cases radiation therapy fails to bring about the desired result. Other investigators have been unfavorably impressed by the severe reactions which follow the irradiation of the more radioresistant types of lesions. In 1930 Taussig[2] conceived the idea of combining iliac lymphadenectomy with irradiation of the primary neoplasm in the clinical Stage II cases of cancer of the cervix since it was assumed that irradiation failures are most apt to occur in those cases in which there is definite evidence of metastases to the regional lymph nodes. From that time until October, 1942, Taussig and his associates have performed 175 iliac lymphadenectomies with an operative mortality of about 1 per cent. Carcinoma was present in the lymph nodes of 26.8 per cent of the 175 cases and in this group a five year survival rate of 21 per cent was obtained. Taussig also recommended the Wertheim operation with removal of the lymph nodes in preference to radiation therapy in the majority of clinical Stage I cases. He cautioned, however, that for persons untrained in the technique of radical hysterectomy it is safer and better to do iliac lymphadenectomy with irradiation of the cervix rather than an extensive Wertheim procedure.

Meigs,[3] prompted by similar considerations, in February, 1939, revived the radical Wertheim-Clark operation which he combined with the Taussig iliac lymphadenectomy in a carefully chosen group of clinical Stage I and II cases of cancer of the cervix. In 1945 he reported on 65 cases thus operated upon. The postoperative mortality was reduced to one single death but the incidence of some of the postoperative sequelae, especially of ureterovaginal fistulae, was still rather large, although it was hoped that with a better understanding of the blood supply the situation could be improved. The rigid method of the selection in this series is attested by the fact that cancerous involvement of the lymph nodes was found at operation in only 12 of the 65 cases. In 1949, Meigs, Parsons and Nathanson[4] proposed (at the suggestion of Nathanson) a modification of the Taussig operation. Instead of exploring the pelvic lymph nodes through the transabdominal route a retroperitoneal approach is employed and all the lymph nodes of the iliac, hypogastric and obturator areas are removed. This method, which according to the authors must be considered experimental, is used following a complete course of radiation therapy. In a very recent article Morris and Meigs[5] deplore the number of total hysterectomies which are being done under the guise of radical operation for cancer of the cervix and advise that, while the possibilities of surgery are being re-explored, this type of work be limited to institutions equipped for investigative radical surgery.

(3) The fact that cancer of the cervix, even in the presence of extensive involvement of neighboring structures, remains confined within the pelvis for long periods has, during the last few years, led to the development of extremely radical surgical procedures for palliative purposes. In 1948 Brunschwig[6] described the exenteration operation, recommended for primary carcinoma of the uterus which has invaded the bladder and lower bowel. This operation consists of removal of all pelvic viscera with implantation of both ureters into the sigmoid colon and end abdominal colostomy. Obviously the procedure is a formidable one necessitating a large auxiliary team conversant with many highly specialized supportive techniques and having at its disposal the most modern operating

[2] Taussig, F. J. Iliac lymphadenectomy for group II cancer of cervix; technique and 5 year results in 175 cases. *Am. J. Obst. & Gynec.*, 1943, *45*, 733–748.

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[5] Morris, J. McL., and Meigs, J. V. Carcinoma of cervix; statistical evaluation of 1,938 cases and results of treatment. *Surg., Gynec. & Obst.*, Feb., 1950, *90*, 135–150.

[6] Brunschwig, A. Complete excision of pelvic viscera for advanced cancer; one-stage abdominoperineal operation with end colostomy and bilateral ureteral implantation into colon above colostomy. *Cancer*, 1948, *1*, 177–183.

room facilities. The great inconvenience is that the patient is given a permanent wet colostomy since both urine and feces are discharged from the colostomy. In an attempt to spare the colon, Brunschwig, in association with Jordan and Pierce,[7] later described a new technique which is applicable to all cases of carcinoma of the cervix, vagina or vulva which has extended to the bladder but does not involve the rectum. This operation consists of excision of the entire vagina, bladder, uterus, and pelvic lymph nodes with bilateral ureteral implantation into the sigmoid colon. The postoperative mortality (within twenty-eight days after operation) amounted to 25 per cent in a group of 48 patients in which a complete pelvic exenteration was performed and 22 per cent in a group of 36 patients in which partial pelvic exenteration was done.

It was inevitable that the re-exploration of the field of radical surgery and especially the introduction of such extremely heroic procedures to replace or supplement well founded and more or less generally accepted irradiation methods for the treatment of cancer of the cervix should be followed with careful analysis and justifiable criticism. For the surgical task, as so vividly expressed by Morris and Meigs, has not as yet emerged from the experimental stage and the tremendous effort, although overwhelming in its scope, must await the confirmation of time and unbiased clinical observation. Schmitz[8] in a very timely article on the management of cancer of the cervix with special emphasis on the controversial points states that so far there is no evidence that surgical treatment has produced more uniformly satisfactory end results than radiation therapy or that the cell type or microscopic grading of tumors furnishes us with evidence of a choice of surgical treatment. He therefore believes, that surgery should be reserved for those cases which prove resistant to irradiation or show stubborn persistence by cellular study. The evisceration operations may give relief to a few of the heretofore hopeless patients who have received all possible irradiation or who present themselves for treatment in a very advanced stage of the disease, but should not be carried out except under most ideal working conditions.

The American Radium Society made a notable contribution towards the advancement of the solution of this problem, when, at its Thirty-second Annual Meeting held on May 25 and 26, 1950, at the Roosevelt Hotel in New York, an excellent symposium was given dealing with all phases of cancer of the cervix. Under the able chairmanship of Dr. Leland R. Cowan of Salt Lake City, the outstanding leaders in their respective fields participated in the presentation of the various subjects including such distinguished names as Dr. Gerald A. Galvin, Dr. Gray H. Twombly, Dr. Joe Vincent Meigs, Dr. James F. Nolan, Dr. Herbert E. Schmitz and Dr. Alexander Brunschwig. A very illuminating and most fruitful discussion of the critical problems by eminent authorities followed the symposium, among whom were Dr. James A. Corscaden, Dr. William P. Healy, Dr. A. N. Arneson, Dr. George W. Waterman and Dr. H. L. Kottmeier of Sweden. The papers and discussion of the symposium will be published in a future issue of this JOURNAL.

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[8] Schmitz, H. E. Management of carcinoma of cervix, with emphasis on controversial factors in treatment. *S. Clin. North America*, Feb., 1950, *30*, 249–257.

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. Barton R. Young, Germantown Hospital, Philadelphia 44, Pa. Annual meeting: Jefferson Hotel, St. Louis, Mo., Sept. 26–29, 1950.

AMERICAN RADIUM SOCIETY
Secretary, Dr. J. E. Wirth, U. S. Marine Hospital, Baltimore, Md. Annual meeting: 1951, to be announced.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. D. S. Childs, 713 E. Genesee St., Syracuse 2, N. Y., Annual meeting: Palmer House, Chicago, Ill., Dec. 10–15, 1950.

AMERICAN COLLEGE OF RADIOLOGY
Executive Secretary, William C. Stronach, 20 N. Wacker Drive, Chicago 6.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. Paul C. Hodges, 950 E. 59th St., Chicago, Ill.

ALABAMA RADIOLOGICAL SOCIETY
Secretary, Dr. W. W. Anderson, Tuscaloosa, Ala. Meets time and place Alabama State Medical Association.

ARIZONA ASSOCIATION OF PATHOLOGISTS AND RADIOLOGISTS
Secretary, Dr. R. Lee Foster, 507 Professional Bldg., Phoenix, Ariz. Two regular meetings a year. The annual meeting at time and place of State Medical Association and interim meeting six months later.

ARKANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Fred Hames, 511 National Bldg., Pine Bluff, Ark. Meets every three months and also at time and place of State Medical Association.

ATLANTA RADIOLOGICAL SOCIETY
Secretary, D. W. W. Bryan, 490 Peachtree St., N.E., Atlanta, Ga. Meets monthly, except during three summer months, on second Friday evening.

BROOKLYN ROENTGEN RAY SOCIETY
Secretary, Dr. J. J. Daversa, 345 75th St., Brooklyn, N. Y. Meets monthly fourth Tuesday, Oct. through April.

BUFFALO RADIOLOGICAL SOCIETY
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Secretary, Dr. Dwight V. Needham, 608 E. Genesee St., Syracuse N. Y. Meets January, May, November.

CENTRAL OHIO RADIOLOGICAL SOCIETY
Secretary, Dr. F. A. Riebel, 15 West Goodale St., Columbus, Ohio. Meets at 6:30 P.M. on second Thursday of October, December, February, April, and June at Columbus Athletic Club, Columbus, Ohio.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. B. D. Braun, 6 N. Michigan Ave., Chicago 2, Ill. Meets second Thursday of each month, October to April inclusive at the University Club.

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Secretary, Dr. Paul E. RePass, 306 Republic Bldg., Denver 2, Colo. Meets third Friday of each month at University of Colorado Medical Center or at Denver Athletic Club.

CONNECTICUT VALLEY RADIOLOGIC SOCIETY
Secretary, Dr. E. W. Godfrey, 1676 Boulevard, West Hartford, Conn. Meets second Friday Oct. and April.

DALLAS-FORT WORTH ROENTGEN STUDY CLUB
Secretary, Dr. X. R. Hyde, Medical Arts Bldg., Fort Worth, Texas. Meets in Dallas on odd months and in Fort Worth on even months, on third Monday, 7:30 P.M.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. W. G. Belanger, Harper Hospital. Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

EAST BAY ROENTGEN SOCIETY
Secretary, Dr. Dan Tucker, 434-30th St., Oakland 9, Calif. Meets first Thursday each month at Peralta Hospital, Oakland.

FLORIDA RADIOLOGICAL SOCIETY
Secretary, Dr. F. K. Hurt, Riverside Hospital, Jacksonville, Fla. Meets twice annually, in the spring with the annual State Society meeting, and in the fall.

GEORGIA RADIOLOGICAL SOCIETY
Secretary, Dr. R. C. Pendergrass, Americus, Ga. Meets in mid-winter and at annual meeting of Medical Association of Georgia in the spring.

GREATER MIAMI RADIOLOGICAL SOCIETY
Secretary, Dr. David Kirsh, 712 duPont Bldg., Miami 32, Florida. Meets last Wednesday of each month at 8:00 P.M. at Veterans Administration Regional Office.

HOUSTON X-RAY CLUB
Secretary, Dr. Curtis H. Burge, 3020 San Jacinto St. Houston 4, Texas. Meets fourth Monday each month.

RADIOLOGICAL SOCIETY OF KANSAS CITY
Secretary, Dr. Arthur B. Smith, 800 Argyle Bldg., Kansas City, Mo. Meets third Thursday of each month.

ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. Wm. DeHollander, St. John's Hospital, Springfield, Ill. Meets three times a year.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. William M. Loehr, 712 Hume-Mansur Bldg., Indianapolis 4. Meets second Sunday in May.

IOWA X-RAY CLUB
Secretary, Dr. Arthur W. Erskine, 326 Higley Bldg., Cedar Rapids, Iowa. Luncheon and business meeting during annual session of Iowa State Medical Society. Special meetings by announcement.

KANSAS RADIOLOGICAL SOCIETY
Secretary, Dr. Anthony F. Rossitto, Wichita Hospital, Wichita, Kan. Meets annually with State Medical Society.

KENTUCKY RADIOLOGICAL SOCIETY
Secretary, Dr. W. C. Martin, 321 W. Broadway, Louisville. Meets annually in Louisville on first Saturday in Apr.

KINGS COUNTY RADIOLOGICAL SOCIETY
Secretary, Dr. Marcus Wiener, 1430-48th St., Brooklyn, N. Y. Meets Kings County Med. Soc. Bldg. monthly on fourth Thursday, October to May, 8:45 P.M.

LOS ANGELES RADIOLOGICAL SOCIETY
Secretary, Dr. Wybren Hiemstra, 1414 S. Hope St., Los Angeles 15, Calif. Meets second Wednesday each month at Los Angeles County Medical Assn. Building.

LOUISIANA RADIOLOGICAL SOCIETY
Secretary, Dr. J. R. Anderson, 1130 Louisiana Ave., Shreveport. Meets annually during Louisiana State Medical Society Meeting.

* Secretaries of societies are requested to send timely information promptly to the Editor

Louisville Radiological Society
Secretary, Dr. E. L. Pirkey, Louisville General Hospital, Louisville 2, Ky. Meets monthly on second Friday at Seelbach Hotel, Louisville.

Miami Valley Radiological Society
Secretary, Dr. G. A. Nicoll, 134 Apple St., Dayton, Ohio. Meets second Friday of fall and winter months.

Michigan Association of Roentgenologists
Secretary, Dr. R. D. McDuff, 220 Genesee Bank Bldg., Flint 3, Mich.

Milwaukee Roentgen Ray Society
Secretary, Dr. T. J. Pfeffer, 839 N. Marshall St., Milwaukee 2, Wis. Meets monthly on second Monday at University Club.

Minnesota Radiological Society
Secretary, Dr. L. A. Nash, 572 Lowry Medical Arts Bldg., St. Paul 2, Minn. Meets three times annually, once at time of State Med. Assn., and in spring and fall.

Nebraska Radiological Society
Secretary, Dr. J. E. Downing, 816 Medical Arts Bldg., Omaha, Nebr. Meets fourth Thursday of each month at 6 P.M. at Omaha or Lincoln.

New England Roentgen Ray Society
Secretary, Dr. George Levene, Massachusetts Memorial Hospitals, Boston, Mass. Meets monthly on third Friday, Harvard Club.

New Hampshire Roentgen Ray Society
Secretary, Dr. A. C. Johnston, Elliott Community Hospital, Keene, N. H. Meets four to six times yearly.

New York Roentgen Society
Secretary, Dr. J. L. Olpp, 49 Ivy Lane, Tenafly, N. J. Meets monthly on third Monday, New York Academy of Medicine, at 8:30 P.M.

North Carolina Radiological Society
Secretary, Dr. J. E. Hemphill, 1420 E. Fifth St., Charlotte 4, N. C. Meets in May and October.

North Dakota Radiological Society
Secretary, Dr. C. O. Heilman, 807 Broadway, Fargo. Meetings by announcement.

Northern California Radiological Club
Secretary, Dr. C. W. Wauters, 701 High St., Auburn, Calif. Meets at dinner last Monday, every second month, except June, July and August.

Ohio State Radiological Society
Secretary, Dr. E. C. Elsey, 927 Carew Tower, Cincinnati 2, Ohio.

Oklahoma State Radiological Society
Secretary, Dr. W. E. Brown, 21st & Xanthus, Tulsa 4, Okla. Three regular meetings annually.

Oregon Radiological Society
Secretary, Dr. C. T. Jessell, 214 Medical-Dental Bldg., Portland 5, Oregon. Meets monthly 2nd Wednesday, 8:00 P.M.

Orleans Parish Radiological Society
Secretary, Dr. Joseph V. Schlosser, Charity Hospital, New Orleans 13, La. Meets first Tuesday of each month.

Pacific Northwest Radiological Society
Secretary, Dr. S. J. Hawley, 1320 Madison St., Seattle 4, Wash. Meets annually in May.

Pacific Roentgen Society
Secretary, Dr. L. H. Garland, 450 Sutter St., San Francisco, Calif. Meets annually, during meeting of California Medical Association.

Pennsylvania Radiological Society
Secretary, Dr. J. M. Converse, 416 Pine St., Williamsport.

Philadelphia Roentgen Ray Society
Secretary, Dr. G. P. Keefer, American Oncologic Hospital, Philadelphia 4, Pa. Meets first Thursday each month October to May, at 8:00 P.M., in Thomson Hall, College of Physicians.

Pittsburgh Roentgen Society
Secretary Dr. E. J. Euphrat, 3500 Fifth Ave., Pittsburgh 13, Pa. Meets 6:30 P.M. at Webster Hall Hotel on second Wednesday each month, October to May inclusive.

Queens Roentgen Ray Society
Secretary, Dr. J. E. Goldstein, 88-29 163rd St., Jamaica 3, N. Y. Meets fourth Monday of each month except during the summer.

Radiological Section, Baltimore Medical Society
Secretary, Dr. Harry A. Miller, 2452 Eutaw Place, Baltimore. Meets third Tuesday each month, Sept. to May.

Radiological Section, Connecticut Medical Society
Secretary, Dr. Fred Zaff, 135 Whitney Ave., New Haven, Conn. Meets bimonthly on second Wednesday.

Radiological Section, District of Columbia Medical Society
Secretary, Dr. K. C. Corley, 1835 Eye St., N. W., Washington, D. C. Meets Medical Society Auditorium, third Thursday, Jan., March, May, Oct. at 8:00 P.M.

Radiological Section, Southern Medical Association
Secretary, Dr. Roy G. Giles, Temple, Texas.

Radiological Society of New Jersey
Secretary, Dr. Peter Gianquinto, 685 High St., Newark, N. J. Meets annually at Atlantic City at time of State Medical Society and mid-winter at Elizabeth, N. J.

Rochester Roentgen Ray Society, Rochester, N. Y.
Secretary, Dr. A. V. Winchell, 40 Meigs St., Rochester, N. Y. Meets monthly on last Monday from September through May, 8 P.M. at Strong Memorial Hospital.

Rocky Mountain Radiological Society
Secretary, Dr. Maurice D. Frazer, 1037 Stuart Bldg., Lincoln, Nebr. Meets Shirley-Savoy Hotel, Denver, Colo., Aug. 17, 18, 19, 1950.

St. Louis Society of Radiologists
Secretary, Dr. H. R. Senturia, Pasteur Medical Building, St. Louis, Mo. Meets fourth Wednesday each month, except June, July, August, and September.

San Diego Roentgen Society
Secretary, Dr. R. F. Niehaus, 1831 Fourth Ave., San Diego, Calif. Meets monthly, first Wednesday at dinner.

Section on Radiology, California Medical Association
Secretary, Dr. D. R. MacColl, 2007 Wilshire Blvd., Los Angeles 5, Calif.

Section on Radiology, Illinois State Medical Society
Secretary, Dr. Harold L. Shinall, St. Joseph's Hospital, Bloomington, Ill.

Shreveport Radiological Club
Secretary, Dr. R. W. Cooper, Charity Hospital, Shreveport, La. Meets monthly on third Wednesday, at 7:30 P.M., September to May inclusive.

South Carolina X-Ray Society
Secretary, Dr. S. H. Fisher, 107 E. North St., Greenville, S. C. One meeting with South Carolina Medical Association in May, others arranged by President.

Tennessee Radiological Society
Secretary, Dr. J. M. Frère, 707 Walnut St., Chattanooga, Tenn. Meets annually at the time and place of the Tennessee State Medical Association.

Texas Radiological Society
Secretary, Dr. R. P. O'Bannon, 650 Fifth Ave., Fort Worth 4, Texas. Next meeting, Galveston, Texas, January 19 and 20, 1951.

University of Michigan Department of Roentgenology Staff Meeting
Meets each Monday evening from September to June, at 7 P.M. at University Hospital.

University of Wisconsin Radiological Conference
Secretary, Dr. E. A. Pohle, 1300 University Ave., Madison, Wis. Meets first and third Thursdays 4:00 to 5:00 P.M., September to May inclusive. Room 203, Service Memorial Institute, 426 N. Charter St., Madison.

Utah State Radiological Society
Secretary, Dr. Angus K. Wilson, 343 S. Main St., Salt Lake City 1, Utah. Meets third Wednesday in September, November, January, March and May.

Virginia Radiological Society
Secretary, Dr. P. B. Parsons, Norfolk General Hospital, Norfolk, Va. Meets annually in October.

Washington State Radiological Society
Secretary, Dr. R. C. Kiltz, 705 Medical-Dental Bldg., Everett, Wash. Meets fourth Monday each month, October through May, College Club, Seattle.

Wisconsin Radiological Society
Secretary, Dr. Irving I. Cowan, 425 E. Wisconsin Ave., Milwaukee 2, Wis. Special meetings held during year; annual meeting each spring at Madison, Wis.

X-Ray Study Club of San Francisco
Secretary, Dr. M. A. Sisson, 450 Sutter St., San Francisco, 8, Calif. Meets January to July, Lane Hall, Stanford University Hospital, and July to December at San Francisco Hospital.

Cuba, Mexico and Central America

Sociedad de Radiología y Fisioterapia de Cuba
President, Dr. J. Manuel Viamonte, Hospital Mercedes, Habana, Cuba. Meets monthly in Habana.

Sociedad Mexicana de Radiologia y Fisioterapia
General Secretary, Dr. D. P. Cossio, Marsella No. 11, Mexico, D. F. Meets first Monday of each month.

Sociedad Radiológica Panameña
Secretary, Dr. L. Arrieta Sanchez, Apartado No. 86 Panama, R. de P. Meets monthly in a department of radiology of a local hospital, chosen at preceding meeting.

British Empire

British Institute of Radiology Incorporated with the Röntgen Society
Ordinary meeting, on the Thursday preceding the third Friday, October to May at 8:15 P.M.
Medical Members' meeting, on third Friday in each month at 5:00 P.M., 32 Welbeck St., London, W 1.

Faculty of Radiologists
Honorary Secretary, Dr. J. F. Bromley, 45, Lincoln's Inn Fields, London, W.C.2, England.

Section of Radiology of the Royal Society of Medicine (Confined to Medical Members)
Meets third Friday each month at 4:45 P.M. at the Royal Society of Medicine, 1 Wimpole St., London.

Canadian Association of Radiologists
Honorary Secretary-Treasurer, Dr. Jean Bouchard, Suite 305, 1555 Summerhill Avenue, Montreal 26, Que. Meetings January and June.

Section of Radiology, Canadian Medical Association
Secretary, Dr. C. M. Jones, Inglis St., Ext. Halifax, N. S.

Société Canadienne-Française d'Electrologie et de Radiologie Médicales
Secretary, Dr. Origéne Dufresne, 4120 Ontario St., East, Montreal, P. Q.

Australian and New Zealand Association of Radiologists
Honorary Secretary, Dr. Alan R. Colwell, 135 Macquarie St., Sydney, N.S.W.
Honorary Secretaries, State Branches:
New South Wales, Dr. E. W. Frecker, 135 Macquarie St., Sydney.
Victoria, Dr. T. I. Tyrer, 3 Lockerbie Court, East St. Kilda.
Queensland, Dr. J. Adam, 131 Wickham Terrace, Brisbane.
South Australia, Dr. R. de G. Burnard, 170 North Terrace, Adelaide.
Western Australia, Dr. A. M. Nelson, 179-B St. Georges Terrace, Perth.
New Zealand, Dr. E. G. Lynch, 12 Bolton St., Wellington.

South America

Asociacion Argentina de Radiologia
Secretary, Dr. Lidio G. Mocsa, Avda. Gral Paz 151, Córdoba, Argentina. Meetings held monthly.

Sociedad Argentina de Radiologia
Secretary, Dr. Guido Gotta, Buenos Aires, Argentina. Meetings are held monthly.

Sociedad Argentina de Radiología, Filial del Litoral
President, Dr. Francisco P. Cifarelli. Meets monthly second Wednesday, 7:00 P.M., 663 Italia St., Rosario.

Sociedade Brasileira de Radiologia Medica
Secretary, Dr. Nicola Caminha, Av. Mem de Sa, Rio de Janeiro, Brazil. Meets monthly, except during January, February and March.

Sociedade Brasileira de Radioterapia
Secretary, Dr. Oscar Rocha von Pfuhl, Av. Brigadeiro Luiz Antonio, 644 São Paulo, Brazil. Meets monthly on second Wednesday at 9 P.M. in São Paulo at Av. Brigadeiro Luiz Antonio, 644.

Sociedad Peruana de Radiologia
Secretary, Dr. Julio Bedoya Paredes, Apartado, 2306, Lima, Peru. Meets monthly except during January, February and March, at Asociación Médica Peruana "Daniel A. Carrión," Villalta, 218, Lima.

Sociedad de Radiologica, Cancerologia y Fisica Medica del Uruguay
Secretary, Dr. Arias Bellini.

Continental Europe

Société Belge de Radiologie
General Secretary, Dr. S. Masy, 111 Avenue des Alliés, Louvain, Belgium. Meets monthly, second Sunday at Maison des Médecins, Brussels.

Ceskoslovenská společnost pro röntgenologii a radiologii v Praze
Secretary, Dr. Roman Bláha, Praha XII, stát. nemocnice, Czechoslovakia. Meets monthly except during July, August, and September. Annual general meeting.

Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland.

Gdansk Section, Polish Society of Radiology
Secretary, Dr. A. Smigielska, Akademia Lekarska, Gdansk. Meets monthly last Sunday at 10.30, X-Ray Dept., Akademia Gdansk.

Warsaw Section, Polish Society of Radiology
Secretary, Dr. L. Zgliczynski, 59 Nowogrodzka St., Warsaw, Poland. Meets monthly.

Societatea Romana de Radiologie si Electrologie
Secretary, Dr. Oscar Meller, Str. Banual Mărăcine, 30, S. I., Bucuresti, Roumania. Meets second Monday in every month with the exception of July and August.

All-Russian Roentgen Ray Association, Leningrad.
USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson. Meets annually.

Leningrad Roentgen Ray Society
Secretaries, Drs. S. G. Simonson and G. A. Gusterin. Meets monthly, first Monday at 8 o'clock, State Institute of Roentgenology and Radiology, Leningrad.

Moscow Roentgen Ray Society
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky. Meets monthly, first Monday, 8 P.M.

Scandinavian Roentgen Societies
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association.

Sociedad Espanola de Radiologia y Electrologia
Secretary, Dr. J. Martin-Crespo, Fuencarral, 7. Madrid, Spain. Meets monthly in Madrid.

Schweizerische Röntgen-Gesellschaft (Société Suisse de Radiologie)
Secretary, Dr. Max Hopf, Effingerstrasse 47, Bern, Switzerland.

Societa Italiana di Radiologia Medica
Secretary, Prof. Mario Ponzio, Ospedale Mauriziano. Torino, Italy. Meets biannually.

AMERICAN RADIUM SOCIETY

The Thirty-Second Annual Meeting of the American Radium Society was held at the Roosevelt Hotel, New York, on May 25 and 26, 1950, Dr. William S. MacComb of New York, presiding. The morning session of the first day was devoted to a symposium on Cancer of the Cervix Uteri embracing diagnostic methods, growth and spread of the disease and treatment by surgical and radiation methods. In the afternoon, reports were given on dosage factors in five year radiation cures of cancer of the mouth, pharynx and larynx; isodose measurements of linear radium sources in air and water by means of an "automatic isodose recorder"; and rotational and multiportal cross-firing studies with two million volt roentgen rays.

Dr. Otto Glasser of the Cleveland Clinic Foundation presented the Janeway Lecture, the title being "Evolution of Radiological Physcis as Applied to Isotopes." He was presented the Janeway Medal by Dr. Giocchina Failla at the annual dinner on the evening of May 25.

The program on the second day was devoted to the pathology, classification and treatment of tumors of the soft parts, radiation and surgical treatment of cancer of the skin, and the radium treatment of hemangiomas.

The following officers were elected for the year 1950–51: *President*, Dr. Leland R. Cowan, Salt Lake City, Utah; *President-Elect*, Dr. Hugh F. Hare, Boston, Massachusetts; *First Vice-President*, Dr. Howard B. Hunt, Omaha, Nebraska; *Second Vice-President*, Dr. Franz J. Buschke, Seattle, Washington; *Secretary*, Dr. John E. Wirth, Baltimore, Maryland; *Treasurer*, Dr. Grant H. Beckstrand, Long Beach, California; *Member of the Executive Committee*, Dr. William S. MacComb, New York, New York.

The Thirty-Third Annual Meeting of the Society will be held just prior to the next annual meeting of the American Medical Association in 1951. The place and dates will be announced later when the information is available.

The following is a brief outline of the program at the 1950 meeting.

SCIENTIFIC PROGRAM

Thursday Morning, May 25, 1950

1. Presidential Address. William S. MacComb, M.D., New York, N. Y.

Symposium on Cancer of the Cervix Uteri.

2. Diagnostic Methods of Cancer of the Cervix. Gerald A. Galvin, M.D., Baltimore, Md.
3. Growth and Spread of Cancer of the Cervix. Gray H. Twombly, M.D., New York, N. Y.

   Discussion. James A. Corscaden, M.D., New York, N. Y.
4. End Results in the Surgical Treatment of Cancer of the Cervix. Joe Vincent Meigs, M.D., Boston, Mass.
5. Radiation Treatment in Cancer of the Cervix. James F. Nolan, M.D., Los Angeles, Calif.
6. End Results of Radiation Treatment in Cancer of the Cervix. Herbert E. Schmitz, M.D., Chicago, Ill.
7. The Problem of Recurrent Cancer of the Cervix: The Possibilities of Radical Surgery. Alexander Brunschwig, M.D., New York, N. Y.

   Discussion. William P. Healy, M.D., New York, N. Y., and A. N. Arneson, M.D., St. Louis, Mo.

Thursday Afternoon, May 25, 1950

Executive Session.

8. Dosage Factors in 250 Cases of Five-Year Radiation Cures of Mouth, Pharynx, and Larynx Cancer at the Memorial Hospital. Hayes Martin, M.D., New York, N. Y.

   Discussion. Maurice Lenz, M.D., and William Harris, M.D., New York, N. Y.
9. Isodose Measurements of Linear Radium Sources in Air and Water by Means of an "Automatic Isodose Recorder." Gerald J. Hine, Ph.D., and Milton Friedman, New York, N. Y.

   Discussion. Edith H. Quimby, D.Sc., New York, N. Y.
10. Rotational and Multi-Portal Cross-Firing Studies with Two Million Volt X-ray.

John G. Trump, D.Sc., Cambridge, Mass., and Hugh F. Hare, M.D., Boston, Mass.

Discussion. W. Edward Chamberlain, M.D., Philadelphia, Pa.

Janeway Lecture. Evolution of Radiological Physics as Applied to Isotopes. Otto Glasser, Ph.D., and Frank E. Bunts, Cleveland, Ohio.

Friday Morning, May 26, 1950

11. Pathology and Classification of Tumors of the Soft Parts. Arthur Purdy Stout, M.D., New York, N. Y.
12. Treatment of Tumors of the Soft Parts. George T. Pack, M.D., New York, N. Y.

Discussion. William E. Howes, M.D., Brooklyn, N. Y., and Lewis W. Guiss, M.D., Los Angeles, Calif.

13. Radiation Treatment of Cancer of the Skin. George S. Sharp, M.D., Pasadena, Calif.
14. Surgical Treatment of Cancer of the Skin. Thomas W. Stevenson, M.D., New York, N. Y.

Discussion. Theodore P. Eberhard, M.D., Philadelphia, Pa., and James E. Breed, M.D., Chicago, Ill.

15. The Radium Treatment of Hemangiomas. George Clinton Andrews, M.D., New York, N. Y.

Discussion. Harold W. Dargeon, M.D., and Maurice Lenz, M.D., New York, N. Y.

Friday Afternoon, May 26, 1950

Executive Session.

Harry Hauser, M.D.
Chairman of the Publication Committee

CANCER SEMINAR

A Cancer Seminar, sponsored by the Penrose Cancer Hospital, will be held at the Broadmoor Hotel in Colorado Springs on September 9, 1950. Photographic copies of roentgenograms and clinical summaries of 14 problem cases of bone lesions have been sent to participating radiologists. Histopathologic slides of the same 14 cases and their clinical summaries have been sent to participating pathologists. Dr. Philip J. Hodes, of the University of Pennsylvania, and Dr. Lauren V. Ackerman, of Washington University, St. Louis, will be the guest speakers. Cases will be discussed in succession with audience participation. The proceedings of the Cancer Seminar will be recorded and later edited and published. In the evening of September 9 there will be a banquet at which Dr. Charles S. Cameron, Medical and Scientific Director of the American Cancer Society, will be the speaker. Those desiring to attend may write to Dr. James W. McMullen, Penrose Cancer Hospital, Colorado Springs, Colorado.

CONTINUATION COURSE IN NEUROLOGIC ROENTGENOLOGY

The University of Minnesota, Minneapolis, Minnesota, announces a continuation course in Neurologic Roentgenology to be presented at the Center for Continuation Study on October 30 to November 4, 1950. Distinguished visiting physicians who will participate as faculty members of the course include Dr. Arthur E. Childe, Winnipeg; Dr. Philip J. Hodes, Philadelphia; Dr. H. Dabney Kerr, Iowa City; and Dr. Knut Lindblom, Stockholm, Sweden. Clinical and full-time members of the staff of the University of Minnesota and Mayo Foundation will complete the faculty for the course.

Presentations on the anatomy and pathology of the central nervous system will be given early in the course. Emphasis will be placed throughout on different techniques available for the roentgen examination of the central nervous system. Correlation of clinical and roentgenologic findings will be emphasized.

RESEARCH FELLOWSHIPS—THE AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians announces that a limited number of Fellowships in Medicine will be available from July 1, 1951–June 30, 1952. These Fellowships are designed to provide an opportunity for research training either in the basic medical sciences or in the application of these sciences to clinical investigation. They are for the benefit of physicians who are in the early stages of their preparation

for a teaching and investigative career in Internal Medicine. Assurance must be provided that the applicant will be acceptable in the laboratory or clinic of his choice and that he will be provided with the facilities necessary for the proper pursuit of his work. The stipend will be from $2,200 to $3,200.

Application forms will be supplied on request to The American College of Physicians, 4200 Pine Street, Philadelphia 4, Pa., and must be submitted in duplicate not later than October 1, 1950. Announcement of awards will be made November, 1950.

AMERICAN COLLEGE OF PHYSICIANS

The American College of Physicians will conduct its 32nd Annual Session at St. Louis, Missouri, April 9-13, 1951. Dr. Ralph Kinsella of St. Louis is the General Chairman and will be responsible for local arrangements and for the program of Clinics and Panel Discussions. Dr. William S. Middleton, of Madison, Wisconsin, President of the College, will be in charge of the program of Morning Lectures and Afternoon General Sessions.

Secretaries of medical societies are especially asked to note these dates and, in arranging meeting dates of their societies, to avoid conflicts with the College meeting for obvious mutual benefits.

The 1952 Annual Session of the College will be held at Cleveland, Ohio, April 21–25, 1952.

E. R. Loveland
Executive Secretary

MINNESOTA RADIOLOGICAL SOCIETY

The Minnestoa Radiological Society held its Annual Spring Meeting on June 12, 1950, at Duluth, Minnesota, during the Annual Session of the Minnesota State Medical Association. The meeting was held during the afternoon and evening. The Carman Memorial Lecture was given by Dr. Eugene P. Pendergrass, Professor of Radiology of the University of Pennsylvania. Dr. Pendergrass chose as his title "The Roentgen Diagnosis of Silicosis." This was followed by the annual business meeting and election of officers. At the dinner the speaker was Dr. Pendergrass whose subject was "Meningiomas."

OKLAHOMA STATE RADIOLOGICAL SOCIETY

At a meeting of the Oklahoma State Radiological Society in Oklahoma City, June 4, 1950, the following officers were elected for 1950–1951: *President*, Dr. Peter E. Russo, Oklahoma City, Oklahoma; *Vice-President*, Dr. H. B. Yagol, Ada, Oklahoma; *Secretary-Treasurer*, Dr. Walter E. Brown, Tulsa, Oklahoma.

OREGON RADIOLOGICAL SOCIETY

The newly elected officers of the Oregon Radiological Society are as follows: *President*, Dr. Benjamin Goldberg; *Vice-President*, Dr. Richard J. Raines; *Secretary-Treasurer*, Dr. C. Todd Jessell.

COURSE IN INSTRUMENTATION FOR RADIOISOTOPE WORK

The Special Training Division of the Oak Ridge Institute of Nuclear Studies will conduct a two-week course in instrumentation for radioisotope work from September 5 to 15, 1950. Emphasis will be on fundamental instrumentation for applied nuclear science problems.

The course will be open to chemical instrument specialists, electrical engineers, physicists, or others specializing in instrumentation. A knowledge of nuclear radiation properties and experience in electronic instrument design are prerequisites for attendance at the course, which will be limited to 40 participants.

One day each week will be spent on such subjects as proportional counters, construction practices, fast circuits, electrometers, scintillation counters, etc. Morning sessions will be devoted to a formal discussion of specific topics by a specialist in that field, with the afternoon sessions given over to informal discussions and group participation.

The courses will be conducted in the Institute's Training Building within the city of Oak Ridge. Security clearance is not required for access to this area. The building contains excellent laboratories for radioisotope training, a counting room, a well-stocked technical library and associated facilities for the conduction of courses of this nature. Specialists in various fields of instrumentation will supplement the Special Training Division staff in the conduction of the course.

A registration fee of $25, payable on arrival at Oak Ridge, is charged for the course. Participants will be expected to pay their own living and traveling expenses.

Additional information and application blanks may be obtained from Dr. Ralph T. Overman, Chairman, Special Training Division, Oak Ridge Institute of Nuclear Studies, P.O. Box 117, Oak Ridge Tennessee.

NEW LABORATORY FOR RESEARCH ON RADIOISOTOPES

The opening of a new laboratory for research involving radioisotopes at the National Institute of Health of the Public Health Service at Bethesda, Maryland, has been announced by Dr. Leonard Scheele, Surgeon General of the Public Health Service. This is one of the few radioisotope laboratories in America designed solely for medical research.

The Isotope Laboratory is prepared for immediate experimentation in a wide variety of fields. These include new projects and several which had been in progress in other National Institute of Health laboratories. Some of the projects are as follows:

(1) A study with radioactive iodine to determine how the thyroid gland function depends on dietary intake for both normal and thyroid tumor tissue.

(2) A study on the biological effects of alpha particles from radon, and a comparison of these effects with other types of radiation, especially roentgen rays.

(3) A study with radioactive phosphorus involving the metabolism of various phosphorus compounds.

(4) A study with carbon^{14} to determine the distribution of chemotherapeutic agents thought to have value in the treatment of cancer. The effects of these radioactive compounds on both normal and cancerous tissue will also be examined.

In the construction of the isotope laboratory special attention was given to affording the maximum facilities for experimentation with radioisotopes and at the same time to affording maximum protection against radiation hazards.

Much of the laboratory's construction and equipment is experimental and allows the addition of new equipment or replacement of old with the development of new materials and techniques.

An important feature is the fact that the operations of the Isotope Laboratory are under the constant supervision of a "radiation safety group" consisting of five scientists who are especially trained in the proper handling of radioactive substances. This group, always on duty while an experiment is in progress, constantly monitors the various operations with special instruments that can detect and measure radioactivity in amounts far below dangerous levels. Under such circumstances, they can correct an abnormal laboratory situation not only before it becomes unsafe for the staff, but also before it can affect the validity of current and future experiments.

Vol. 64, No. 2

ABSTRACTS OF RADIOLOGICAL LITERATURE

Department Editor: T. Leucutia, M.D., Harper Hospital, Detroit 1, Michigan

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ROENTGEN DIAGNOSIS

HEAD

Elvidge, Arthur R., and Jackson, Ira J. Subdural hematoma and effusion in infants. *Am. J. Dis. Child.*, Nov., 1949, *78*, 635–645.

In this paper, 55 cases of subdural hematomas in infants are presented and the importance of maintaining an adequate fluid and protein balance is stressed. The cases are divided with reference to etiologic and symptomatologic analysis into three groups: (1) group of definite birth injuries; (2) group of probable birth injuries; (3) groups with postnatal head injuries. The clinical picture is described and the subdural puncture is regarded as the only positive method of diagnosing the subdural effusion without direct visualization. Roentgenograms of the skull may reveal evidence of fracture or separation of suture lines, dependent on the circumstances.

In the case of the hydrocephalic infant pneumography is of special value in the diagnosis and degree and type of hydrocephalus and of the existence of subdural effusion. It is useful after an operative procedure in order to estimate the amount, if any, of residue in the subdural space, to determine a shift of midline structures or to follow the degree of ventricular dilatation or cerebral atrophy. If ventricular dilatation and increased pressure exist, ventriculography by way of the anterior fontanel is the method of choice. An encephalogram is difficult to make and may be dangerous if an abnormal increase in intracranial pressure exists. However, the authors believe it may be justifiable when the brain pressure is not high in order to determine the amount of residual displacement or in diagnosis in a complicated case. Roentgenograms of the skull and oxygen studies are then of value for obvious reasons.

When a subdural accumulation is present, it is usually widespread. It causes a compression of the surface of the hemisphere and may obliterate the local subarachnoid channels. If sufficient reduction of the cerebrospinal pathway results, a secondary internal hydrocephalus of the communicating variety develops. There is apparently no characteristic feature in the encephalogram for subdural effusion in infants, unless perhaps a fluid level seen in the subdural space when positioning the head for the brow up and brow down films or a displacement of the brain away from the inner table of the skull. If the effusion is unilateral or greater on one side than on the other, there will be a shift of the midline structures away from the side of the lesion. In a unilateral lesion, in addition to the aforementioned signs, a smooth filling defect in the ventricular system may be seen. The pneumographic findings of bilateral effusion of almost equal size present a communicating hydrocephalus with no shift of the midline structures and displacement away from the inner table.

The surgical treatment consisting of emptying the subdural space and completely removing the membranes when they are present is given in detail.—*R. S. Bromer, M.D.*

James, T. G. I. Thrombosis of the internal carotid artery. *Brit. M. J.*, Dec. 3, 1949, *2*, 1264–1267.

Occlusion of the intracranial branches of the internal carotid artery is considered a frequent cause of hemiplegia, but obstruction of the internal carotid in the neck was considered infrequent and rarely thought of as a cause of hemiplegia.

Carotid arteriography, introduced by Egas Moniz *et al.* (1937) is the only method of accurate diagnosis of thrombosis of the internal carotid artery. Recent reports in the literature indicate that the condition is not rare and is a frequent cause of neurological disturbances. Arteriosclerosis and thromboangiitis have been suggested as causes, but the etiology remains obscure.

The extent of neurological disturbances from thrombosis of the internal carotid artery depends on the rapidity of occlusion and the degree of collateral circulation.

Hemiplegia usually comes on suddenly, often preceded by headaches and dizziness. The lower extremity is less frequently involved than the upper. Visual and sensory changes may occur, also aphasia if the appropriate side is involved.

Three cases are reported in men aged forty-two, fifty-two and thirty-eight respectively, In all 3 cases arteriography demonstrated obliteration of the internal carotid artery 2 cm. above the bifurcation. Encephalography was done in 2 cases and demonstrated enlargement of the lateral ventricle without displacement and brain atrophy on the same side.—*W. H. Shehadi, M.D.*

Young, Barton R. Roentgen demonstration of displaced intracranial physiologic calcifi-

cation and its significance in the diagnosis of brain tumors and other space-occupying diseases. *Radiology*, Nov., 1949, *53*, 625–632.

The author, in an excellently developed article, reviews the adoption of pineal displacement as an indication of space occupying intracranial lesions. The Vastine-Kinney charts are reproduced and the methods of Dyke and Fray in evaluating pineal position as seen in the lateral film are reviewed. A side to side pineal deviation of more than 2.5 mm. is to be considered indicative of a significant abnormality, usually a space-taking lesion. Stereoscopic views in the lateral, dorsal and ventral projections are often needed for identification of the pineal body.

Displacements of calcified choroid plexuses and calcified falx by space-taking lesions are discussed. The causes of physiological calcification displacement are discussed. Those enumerated in order of frequency are: tumors (primary and metastatic), hematoma (subdural and intracerebral), brain abscesses, cyst, and granuloma. Many illustrations are given.

The author stresses the importance of differentiating physiologic dural calcification from meningioma calcification.—*S. H. Fisher, M.D.*

Pendergrass, Eugene P., Hope, John W., and Perryman, Charles R. The roentgen diagnosis of meningiomas of the sphenoidal ridge. *Radiology*, Nov., 1949, *53*, 675–710.

Meningiomas, constituting about 15 per cent of all brain tumors, are among the few intracranial neoplasms which lend themselves to successful surgical removal. There is need for close cooperation between the neurosurgeon, the neurologist, and the roentgenologist.

Histogenesis of meningiomas is presented with a statement by the authors that the matter has been presented solely to emphasize to the roentgenologist that the histogenesis of this type of tumor is still undetermined.

Grossly, the tumors are of two forms: massive or global meningioma and the meningioma en plaque or the flat type. The global form is not likely to produce severe hyperostosis of regional bone but invaginates the pia into the brain while the flat or en plaque type has a limited thickness and grows along the plane of the meninges usually producing a severe degree of hyperostosis. Microscopic descriptions with classifications are given and the degree of malignancy of this neoplasm is briefly discussed.

Meningiomas are capable of causing erosion, absorption, hyperostosis, or eburnation of bone, either through actual infiltration of the haversian canals or by the reactive hyperemia they provoke. Underlying factors pertinent to these changes are discussed.

The position of meningiomas may be roughly divided into two, namely tumors of the vault and tumors of the base. The authors have found that 14.5 per cent of the meningiomas which they have studied between January, 1930, and January, 1949, were meningiomas of the sphenoidal ridge.

The symptoms of meningioma of the sphenoidal ridge are dependent upon the position of the tumor whether it be deep, inner or clinoidal, middle or alar, outer or pterional. In the deep type unilateral failure of vision associated with primary optic atrophy is most common. The middle type, often asymptomatic for a long time, presents choked discs, more advanced on the side of the lesion. In the outer or pterional group symptomatic manifestation depends upon whether the tumor is of the flat or en plaque or global type but unilateral exophthalmus and visual disturbance are the most frequent findings.

In a discussion of roentgen diagnosis an anatomic landmark is described in the base (Hirtz) view of the skull. A curvilinear shadow has been described at times as representing the lesser wing of the sphenoid. This has been shown by the authors to be the anterior superior surface of the greater wing of the sphenoid in the region of the sphenofrontal suture. The roentgen signs of a meningioma of the inner third are hyperostosis of ipsilateral anterior clinoid, the optic canal, and the inner portion of the lesser wing of the sphenoid, seen best in the posteroanterior and optic canal views. Middle ridge tumors may show hyperostosis or bone absorption of lesser and greater wings of the sphenoid or very pronounced hyperostosis regionally, dependent upon type of tumor present. The pterional flat type of tumor of the sphenoidal ridge produces a very pronounced hyperostosis of greater and lesser wings of the sphenoid and in some instances of the orbital plate of the frontal bone, the squamous portion of the temporal, and the pterional region itself. The lateral global tumors produce increased vascularity, multiple vascular grooves, in the pterional region, best seen in lateral stereoscopic roentgenograms.

The article closes with case histories of 41 verified sphenoidal ridge meningiomas.

The article is well illustrated and contains four tables.—*J. H. Gilmore, M.D.*

Black, J. I. Munro. Nasopharyngeal tumors. *Laryng. & Otol.*, June, 1949, *63*, 342–349.

This paper deals with the location, signs and symptoms, diagnosis, course, treatment and prognosis of simple and malignant nasopharyngeal tumors.

Tumors announce their presence by disturbance of form and function of structures in and around the nasopharynx. Malignant tumors may be associated with more distant pains and muscular palsies due to nerve involvement as the result of penetrating spread.

Growth characteristics differ with degrees of malignancy. The simple tumor is a space-occupying lesion which will fill the cavity, expand the walls, and follow every natural path of expansion. The malignant tumor may behave much as the simple neoplasm; or it may penetrate the walls of the cavity without necessarily producing any great mass; or it may metastasize early.

Tumors of congenital origin are not classed as true nasopharyngeal tumors by the author, and are only briefly mentioned.

Simple tumors may be of any type and are very rare. The most common is the fibroma. Characteristically it is found in young males, grows at varying rates, and ceases to grow when the host reaches his twenties. The signs and symptoms are those of a simple tumor. Treatment should be complete surgical removal, but the location and vascularity make this difficult. Therefore more conservative surgical management is usually employed. It is radiosensitive to some extent but usually will not undergo complete regression. The untreated lesion is said to run a fatal course in three to six years, but if it is formed when the patient is older growth may cease and regression is said to occur.

A variety of malignant neoplasms occur in the nasopharynx. The anaplastic carcinomas and the sarcomas account for about four-fifths of the total, and the keratinizing squamous carcinoma the remaining one-fifth. The latter is an infiltrating lesion which does not usually grow to any great size locally, but can cause local symptoms. It usually produces neurological signs before it metastasizes. It tends to occur in the lateral or superior walls of the nasopharynx and when infiltrating it follows any anatomical path available.

The more malignant neoplasms, such as the sarcoma or the anaplastic carcinoma, usually metastasize before they produce any great local damage.

The complexity of the clinical picture of malignant nasopharyngeal tumors often leads to incorrect diagnosis. In half of all cases more than six months elapsed between onset of trouble and correct diagnosis. During that period treatment was on a symptomatic basis.

In cases eventually diagnosed as malignant nasopharyngeal tumors:

1. Cervical adenopathy was present in 75 per cent at time of diagnosis, and a first symptom in 32 per cent.

2. Ear symptoms were present in 50 per cent at time of diagnosis, and a first symptom in 23 per cent.

3. Nasophyaryngeal symptoms were present in 50 per cent at time of diagnosis, and a first symptom in 30 per cent.

4. Neurological disturbances were present in 40 per cent at time of diagnosis, and a first symptom in 15 per cent.

Aids to diagnosis of a suspected nasopharyngeal tumor are offered by the laryngologist, the radiologist, and the pathologist.

When symptoms are referable to the eye, a roentgenogram of the base of the skull may show enlargement by bony erosion of the foramen lacerum.

Surgery plays little or no part in the treatment of malignant nasopharyngeal tumors because diagnosis depends largely upon spread and metastasis. Radiotherapy is the only hope for cure or palliation. In the nasopharynx the highly malignant neoplasms have a relatively better prognosis than the malignancies of lower degree because of their greater radiosensitivity.

After adequate radiotherapy the total five year cure of all malignant cases is not likely to exceed 20 per cent. In the presence of neurological signs the figure falls to 10 per cent. In the absence of neck glands the cure rate rises to 30 per cent. The cure rate in the presence of roentgen evidence of bony erosion in the base of the skull is just over 10 per cent; in the absence of such it is 25 per cent. The sarcomas yield a cure rate of 30 per cent, the cure rate of carcinoma is 10 per cent. The lympho-epitheliomas are especially radiosensitive and a cure rate of nearly 40 per cent is obtained.

Irradiation is valuable for palliation. Nearly 75 per cent of all cases can be made symptom-

free, but of these 75 per cent will relapse within one year.

Termination takes an average of two years, and is often the result of intracranical invasion. Twenty-five per cent of fatal cases have distant metastases.

No details are given as to the methods of roentgen or radium treatment.—*W. H. Granger, M.D.*

Ballantyne, J. Chalmers, and Rowe, A. R. Some points in the pathology, diagnosis, and treatment of chronic maxillary sinusitis. *J. Laryng. & Otol.*, June, 1949, *63*, 337–341.

A study of about 200 consecutive and unselected cases was made. The findings of roentgen examinations and transillumination are compared with results of proof puncture. Roentgen examination was found to be the most valuable adjunct to clinical diagnosis. Transillumination was often very misleading.

The occipito-mental view was used in conjunction with the occipito-frontal view.

Roentgen examinations fell into three main groups:

1. Ten cases were perfectly clear on roentgen examination. In these cases, on puncture, there was no naked eye evidence of infection.

2. Eighty-eight cases were completely opaque on roentgen examination. More than 80 per cent of these cases gave positive lavage findings.

3. Eighty-two cases showed the roentgen appearance of thickened membrane. Less than 10 per cent of these cases contained pus or mucopus on lavage.

The results of transillumination were recorded as clear or dull. Only 50 per cent of those recorded as dull showed evidence of infection on lavage, while 33 per cent of those that were clear to transillumination yielded pus or mucopus. Almost 90 per cent of the infected antra that were clear on transillumination were completely opaque on roentgen examination.

Dullness to transillumination may be produced by thickening of the mucosa or bony walls, asymmetry of antra, deviated septum, polypi, cysts, or other tumors. All of these can be diagnosed with considerable accuracy by combined clinical and roentgen examination.

Sedimentation rates were made in a number of patients to determine their value in distinguishing between cases of active infection and cases in which roentgen changes were due to other causes. The results were equivocal. In no case was the reading outside the normal limit.

The part played by allergy in this series of cases was investigated. Histological examinations were made on nasal secretions and biopsies of inferior turbinates. Details are given as to methods and results. It was concluded that an allergic response is more apt to be detected in the nasal mucosa than in the secretions.

The medical treatment given and results achieved are described in detail. Thirty of 66 cases were used as controls. The immediate results were in favor of the treated cases, but the follow-up showed one-fourth of the immediate successes and one-fifth of the controls clinically and roentgenologically clear at the end of three months. If the roentgen examinations were excluded, almost twice the number in each group might be considered successful. Roentgenological improvement may not be seen for many months. No patient was advised to undergo surgical intervention, however, unless he was also clinically unimproved.

Pathological findings in cases submitted to operation showed that failure to respond to treatment or recurrence after treatment was probably due in the majority of cases to pathological changes in the antral mucosa and middle meatus which prevented adequate ventilation and drainage of the sinus involved. Presumably irreversible changes occur and from this point on surgical drainage is required and permanent cure with surface therapy alone is uncommon.—*W. H. Granger, M.D.*

NECK AND CHEST

Magan, M. G. A case of Fissura sterni congenita completa. *Brit. J. Radiol.*, May, 1949, *22*, 286–287.

Two types of congenital sternal fissure are usually described. In the incomplete form the xiphisternum and lower part of the gladiolus may be bifid; this type is not infrequently noted by anatomists. The complete sternal fissure is not so uncommon in association with other gross anomalies, but the isolated defect is rarely described. Embryologically a median rudiment of two strands of cells grows, caudally to form the sternal bands which ultimately form the main part of the sternum. Originally separate, these bands join at their cranial ends at the sixth fetal week and subsequently fuse in a caudal direction.

The author encountered a fifty-two year old

white woman in good health with no gross anatomic anomalies except a narrow central depression extending the entire length of the sternum and a web of skin joining the suprasternal notch with the symphysis menti. In the roentgenograms of the sternum the gladiolus is represented in duplicate by two pairs of sternebrae.—*Harold Fulton, M.D.*

Ioannou, Jean. Aspects bronchographiques de quelques territoires pulmonaires. (Bronchographic aspects of some pulmonary segments.) *Presse méd.*, Dec. 25, 1949, *57*, 1208–1209.

The author reports 15 bronchographic studies demonstrating certain aspects of normal and pathological pulmonary segments. The work of A. Meyer, Dubois de Montreynaud and Sestier on the normal and pathologic pulmonary segments is referred to. The present author presents interesting bronchograms from the large number performed at Laënnec Hospital and Chevilly Sanatorium. They concern the normal roentgen aspect of an auxiliary segment of the posterior part of the right upper lobe, the normal aspect of the middle lobe and the right inferior lobe and pathological aspects and anomalies of the right superior and inferior lobes.—*W. M. Loehr, M.D.*

Boucot, Katherine R., Cooper, David A., Marshall, E. Wayne, and Richardson, Fred MacD. Chest x-ray surveys in general hospitals; a critical review. *Ann. Int. Med.*, Nov., 1949, *31*, 889–898.

In December, 1947, the authors analyzed the 70 mm. photofluorographic units operating at Philadelphia General Hospital and at Temple, Jefferson, and Hahnemann Hospitals as to location of the units, lay-outs, procedure, staff, record-keeping, and follow-up. All four units were found to be deficient in lay-out with inadequate space and lack of a waiting room. Two units had no dressing rooms and a third had inadequate dressing room. There was no adequate system to insure that all admissions reported for photofluorograms, and at only one hospital was there a system which assured that patients were examined before discharge. Film reading appeared to be adequate at all but one of the installations. Three of the four installations were definitely deficient in personnel for record-keeping and follow-up. Only one institution had an adequate system of record-keeping, while a second unit attempted some follow-up which was inadequate, and two units maintained no record-keeping system. At only one unit was there satisfactory follow-up of cases reported as positive.

The authors emphasize that the primary purpose of hospital chest surveys is not diagnostic but is the detection of infectious tuberculosis in order to protect hospital personnel and other patients. This depends upon prompt diagnosis with isolation and appropriate treatment of cases uncovered by survey. They point out that since this is a screening process, films should be "over-read" from the point of view of tuberculosis, and a significant percentage of cases whose films are read as "probably tuberculosis" should ultimately prove to be nontuberculous. To be effective, hospital surveys must include a very high percentage of patients at admission. The authors found that at the largest of the four hospitals studied, 50 per cent of the admissions were made during hours when the unit was not in operation, and they recommend that photofluorographic service be made available around the clock. They further recommend that personnel be available for satisfactory follow-up as well as for the prompt processing of films. The responsibility for referral of admissions should be placed at the admission desk and at the central out-patient department registration desk, and a periodic check should be made to see that all patients are being referred for photofluorography. Provisions should also be made to include within the program those patients who cannot be roentgenographed on admission; and in addition the hospital office should be instructed not to discharge any patient who has not had a photofluorogram.

A case is presented to illustrate that failure to obtain photofluorograms at admission and to follow-up satisfactorily can negate the effectiveness of hospital chest survey services. The literature relative to photofluorographic chest surveys is reviewed.—*M. Horwitz, M.D.*

Calder, E. Fluoroscopic preselection of the tomographic plane in chest lesions with a a note on the use of a double grid. *Brit. J. Radiol.*, Nov., 1949, *22*, 627–633.

A simple fluoroscopic method of determining the most satisfactory position of the patient and the level for best demonstration of a chest lesion is described. This permits certain rapid

demonstration of a lesion with the use of a minimum of films and time.

The patient is fluoroscoped into the most satisfactory position for demonstration of the lesion, and the exact degree of rotation noted. Then, after positioning at right angles to this, and using very narrow vertical diaphragms, lead strips are attached to the two sides of the body under fluoroscopic control to mark the level of the lesion. For filming, the patient is placed on the table in the optimum degree of rotation, and in this position the two lead strips should be the same distance from the table and should mark the level of the lesion. Only one or two films are then necessary.

In addition to the usual movable grid, the author uses a stationary grid with the strips at right angles to the direction of tube motion. If this is placed on the table, it is far enough from the level of focus that it is blurred, but still increases the contrast considerably. An increase in exposure is necessary.—*E. F. Lang, M.D.*

Turletti Tola, A. Osservazioni sull'esame stratigrafico nelle pleuriti essudative; nota preventiva. (Observations on stratigraphic examination in pleural effusions; preliminary note.) *Ann. radiol. diag.*, 1949, *21*, 313–317.

The author has studied cases of uncomplicated pleural effusion by the stratigraphic method. In all these cases he found considerable accentuation and enlargement of hilar and pulmonary vascular markings on the diseased side. The blood vessels are actually larger and pulmonary congestion of the peripheral portion of the lung can be visualized. He believes that the effusion can be accounted for as a reaction to the pulmonary infection and congestion by the adjacent pleura.—*P. E. Russo, M.D.*

Lattanzio, Enrico. Il disegno del reticolo polmonare apicale. (The net-like appearance of the pulmonary apex.) *Ann. radiol. diag.*, 1949, *21*, 358–365.

The author warns against confusing normal vascular shadows in the apex with pathologic lesions. Anteroposterior and posteroanterior roentgenograms are made of the apex with the tube angled so that the surrounding rib shadows are largely avoided.

Changes in the configuration and caliber of the vascular shadows are the most dependable means of distinguishing them from pathologic processes. These changes are seen with cardiac diastole and systole, and also with variations in intrathoracic pressure as in Valsalva's experiment or modifications of it.

Continuity of apical shadows with larger vessels below is also evidence of the nature of these shadows.—*C. Colangelo, M.D.*

Lloyd, Milton Sills. Bullous emphysema. *J. Thoracic Surg.*, Aug., 1949, 18, 532–535.

It is a generally accepted fact that once bullous emphysema has developed, it is permanent and irreversible. The author presents a case in which etiology, origin, development, symptomatology, and disappearance are all recorded. This case is different from the usual case which is nearly always seen in its end stages.

The case reported is that of a two year old infant who developed pneumonia involving the right upper lobe and massive empyema on the left side following chicken-pox and measles. Six weeks later, following surgical treatment of the empyema, a large air sac was seen for the first time in the upper part of the right lung and a residual empyema on the left. With further drainage this cleared up completely, but the air sac in the right lung was considerably larger six weeks later. From this point onward the patient made uniform progress and a film taken about eight months after admission to the hospital showed complete re-expansion of the left lung and complete absorption of air in the cystic formation on the right side. A roentgenogram taken ten years after the illness demonstrated a normal chest.—*F. M. Reis, M.D.*

Vollmer, Hermann. Chronic emphysematous cavity of the lung. *Am. J. Dis Child.*, Nov., 1949, *78*, 755–758.

A case is reported of a pulmonary cyst which was first observed in a six year old girl following a pulmonary infection. Re-examination twenty-three years later revealed that this cavity had persisted without essential change in size and roentgenographic appearance. The course was asymptomatic. Differential diagnostic considerations made an emphysematous cavity the most probable diagnosis. The case of this patient was one of the first described in the literature and has the longest follow-up period. Vollmer believes that it indicates that not all emphysematous cavities disappear spontaneously and

that, nevertheless, a conservative attitude is to be recommended.—*R. S. Bromer, M.D.*

Cassels, D. E., Fritz, J. M., and Adams, W. E. Congenital cystic disease of the lungs. *J. Pediat.*, Nov., 1949, *35*, 585–600.

Congenital cystic disease of the lung is a descriptive term indicating the presence of air- or fluid-filled cavities in the lung, congenital in origin, and lined with bronchial epithelium.

Numerous synonyms exist for the condition. The exact incidence of the disease is uncertain. The basic defect is a developmental fault of the bronchial elements. The terminal respiratory passages form blind, tube-like rests. The condition may be localized to one passage or involve large segments of the lung. The following classification has been proposed by Sellors:

1. Solitary cysts (almost invariably large).
   a. Huge balloon or distention cysts in infants. (Cause pressure signs)
   b. Smaller cysts the size of an orange. (Silent unless infected)
2. Multiple cysts of varying sizes.
   a. Medium-sized in groups of two or three close to the lung roots. (Usually clinically silent if not infected)
   b. Small cysts from size of currant to cherry.
      1. Uniform size in segmental distribution resembling saccular bronchiectasis.
      2. Diffuse lesions with patchy distribution in one lung field or diffuse throughout both lungs.

The cystic spaces usually communicate with a bronchus. A ball-valve mechanism develops producing balloon cysts. These may be confused with tension cysts. Clinical symptoms, except for the balloon cysts of infancy, are due to superimposed infection.

The author groups the cases into three general clinicopathological patterns:

1. Large solitary or multiple cysts surrounded by normal lung. Usually confused with lung abscess or empyema. The cavities drain indefinitely because of the lining epithelium. This condition should always be considered when drained abscesses or empyemas do not respond to adequate treatment.

2. Multiple grape-sized lesions confused with saccular bronchiectasis.

3. Multiple small cystic spaces surrounded by fetal non-aerated lung. These cases are usually confused with suppurative pneumonitis.

The authors present illustrative cases with clinical histories, roentgenogram reproductions and pathological findings. They conclude that the condition should be suspected in chronic suppurative pulmonary disease which does not respond to treatment and areas of pneumonitis, which are non-tuberculous and do not respond to treatment as well as cases in which the roentgen findings are suggestive.—*R. M. Harvey, M.D.*

Waddell, William R., Sniffen, Ronald C., and Sweet, Richard H. Chronic pneumonitis; its clinical and pathologic importance; report of ten cases showing interstitial pneumonitis and unusual cholesterol deposits. *J. Thoracic Surg.*, Oct., 1949, *18*, 707–737.

Ten cases of chronic, nonsuppurative interstitial pneumonitis treated by surgical excision are presented in detail. This type of lesion is often associated with bronchial obstruction, bronchiectasis, or tuberculosis. In the cases presented, however, no major concurrent disease was observed. The onset may be rapid or insidious. Symptoms had persisted one and a half months to five years. Roentgen examination of the chest was helpful in the localization of the disease. A variable portion of the lung usually showed evidence of atelectasis or consolidation, and although the appearance sometimes suggested that of an inflammatory process, the possibility of carcinoma could seldom be excluded with certainty.

Bronchoscopic examination usually showed no abnormality or at most inflammation of the bronchial wall.

The affected lobe was always decreased in volume and fibrous adhesions were apparent. The bronchial lymph nodes were enlarged and firmer than normal. The microscopic appearance was that of a chronic interstitial pneumonitis in association with large numbers of mononuclear cells containing cholesterol and cholesterol esters. The source of the cholesterol was not apparent. Sputum examination for monocytes containing doubly refractive material should prove useful when performed in conjunction with a search for malignant cells. The morphologic findings are compared to other forms of long-standing pneumonitis and particularly to pneumonia due to the aspiration of paraffin oil.

The principal importance of chronic pneumonitis of the type described is that it may be confused with carcinoma of the lungs. Exploratory thoractomy is often the only means of

certain differential diagnosis.—*F. M. Reis, M.D.*

Dunner, Lasar, Hardy, R., and Bagnall, D. J. T. Pneumoconiosis after exposure to sulphur dioxide fumes and dust from coke fires. *Lancet*, Dec. 31, 1949, *2*, 1214–1216.

Pneumoconiotic lesions occurring in a group of workers exposed to sulphur dioxide fumes and dust from coke fires are reported. The roentgenological appearances were those of irregular patchy fibrosis involving both lungs but usually predominant in one. In most cases, the mid and lower lung fields showed nodulation and some confluence resulting in patchy consolidation. Evidences of emphysema were usually present. In the differential diagnosis, tuberculosis was excluded with certainty and pulmonary syphilis and Boeck's sarcoid were carefully considered and ruled out.

A sample of coke-flue dust obtained by one of the workers was analyzed. The fine fraction of this sample contained 34 per cent of total silica, 2.6 per cent of free silica, and 17.5 per cent of iron compounds expressed as iron oxide (Fe_2O_3).

The authors feel that the roentgeographic findings could be accounted for by the chemical composition of coke-flue dust alone. The patchy distribution of the roentgen changes are more readily explicable if it is assumed that protracted exposure to sulphur dioxide has caused localized chronic inflammation in the lungs, and that dust has later accumulated in these affected areas.—*C. N. Borman, M.D.*

Lischi, Giancarlo. Silicosi massive iperplastico-granulomatose. (Massive hyperplastic granulomatous silicosis.) *Ann. radiol. diag.*, 1949, *21*, 318–322.

The author differentiates by roentgenological methods the hyperplastic granulomatous silicosis from the more common nodular fibrotic type.

In the granulomatous lesions, large opaque shadows are seen in either one or both lung fields which are of uniform density and with a sharp border which can be detected early in the course of the disease. These shadows differ from the conglomerate masses usually seen in the nodular fibrotic disease. Some of the theories advanced for the formation of these granulomas are based on the toxicity of other minerals present with the silica, the presence of latent tuberculous infections, nonspecific chronic infection or chemical irritation. The presence of generalized pulmonary fibrosis and nodulation serves as further evidence in these cases of hyperplastic granulomatous silicosis as a guide in making the correct diagnosis.

Two case reports with illustrations are included in the article.—*P. E. Russo, M.D.*

Turner, H. Midgley, and Martin, W. J. Mortality and survival rates in males with silicosis or silico-tuberculosis. *Brit. M. J.*, Nov. 19, 1949, *2*, 1148–1150.

This is a statistical study of 814 men with either pure silicosis or silico-tuberculosis to determine survival rates beyond the age of forty, at which age it is assumed that most silicotic processes are pathologically established. There were 466 men with silico-tuberculosis and 348 men with pure silicosis. Comparison with English life tables for 1930–1932 shows that where 50.3 per cent of men attaining the age of forty are alive at seventy-one years, only 16.3 per cent of pure silicotics and 4.5 per cent of the silico-tuberculous survive similarly. The 50 per cent survival age for the former was sixty-three and for the latter fifty-eight.

Tuberculosis was the cause of death in 313 cases (51.3 per cent). A high proportion of cases complicated by tuberculosis was in grinders (63 per cent), whereas a relatively low proportion was in coal miners (37 per cent). The authors suggest the possiblity of predisposition induced by inhaled iron. They also accord weight to the theory that coal dust in a lung acts as an absorbent of tuberculin and thus reduces the toxicity of any lesions which may occur.

Of the 297 deaths (48.7 per cent) due to causes other than tuberculosis, 70 per cent were respiratory, indicating predisposition to pathology in this area.—*H. J. Klos, M.D.*

Plessinger, V. A., and Jolly, P. N. Rasmussen's aneurysms and fatal hemorrhage in pulmonary tuberculosis. *Am. Rev. Tuberc.*, Nov., 1949, *60*, 589–603.

Rasmussen of Copenhagen in 1868–1869 described carefully the pathologic features of 11 cases in which an aneurysmal pulmonary vessel passed through the wall of a tuberculous cavity and was thought to be the source of the pulmonary hemorrhage which had occurred in

each case. From 667 autopies between 1938 and 1947 at an Ohio hospital, 56 cases were selected in which the patient had died from a massive pulmonary hemorrhage, or in which an unruptured Rasmussen's aneurysm was discovered at autopsy as an incidental finding. Of the 49 patients who died of pulmonary hemorrhage, only 29 exhibited an aneurysm of a pulmonary vessel, but the authors believe that such an aneurysmal dilatation will be found in all cases of massive pulmonary hemorrhage in tuberculous patients if a diligent search is made of properly prepared lung sections.

These aneurysms are not syphilitic in origin and tend to occur in the more chronic forms of pulmonary tuberculosis. Cavity formation (5 mm. to 7 cm. in diameter) occurred in every case, but there was no correlation between the size of the cavity and the incidence of aneurysm formation. The course of the parent vessel was tangential to the wall of the cavity, and most often located in the medial wall of the cavity. Conspicuous foci of pulmonary fibrosis were adjacent to the affected vessel in practically all cases. This fibrosis about the vessel is a potent factor in the massive hemorrhage as it prevents the contraction of the ruptured vessel.

There is no mention of the roentgenographic aspects of this entity.—*Harold Fulton, M.D.*

Furcolow, Michael L. Development of calcification in pulmonary lesions associated with sensitivity to histoplasmin. *Pub. Health Rep.*, Nov. 4, 1949, *64*, 1363–1393.

It is now quite evident that histoplasmosis, formerly thought to be a rare and usually fatal disease, also exists as a mild asymptomatic syndrome. It is indistinguishable from tuberculosis in some cases, except by skin testing and complement fixation tests. Clinically and roentgenographically, they may be the same.

A group of 17 children varying in age from four to fifteen years and followed for periods up to four years is presented. Roentgenograms in the infiltrative phase and after calcification has taken place are reproduced in each of these cases. All of the children remained sensitive to histoplasmin and negative to tuberculin throughout the survey period. The early lesions showed no evidence of progression and no new lesions developed. These precalcific lesions appear as disseminated infiltrates, pneumonic infiltrations or nodular foci and some intermediate lesions are seen. Enlargement of the hilar nodes is frequently observed with the disseminated infiltrates. The calcified lesions as well as the infiltrates themselves are protean in their appearance as illustrated by the accompanying roentgenograms.—*K. L. Krabbenhoft, M.D.*

Pieri, J., and Casalonga. Mise au point d'une technique d'instillation bronchique. (Perfecting of a technique for bronchial instillation.) *Presse méd.*, Sept. 3, 1949, *57*, 786–787.

The authors describe a simple and rapid means of inserting a tracheal catheter for the instillation of lipiodol for bronchography.

After the pharyngeal anesthesia is obtained by their very simple method, a laryngeal sound with a small syringe containing 2 cc. of pontocaine (0.5 per cent) attached at the distal end is placed at the base of the tongue. The passage of the instrument over the epiglottis, the injection of the pontocaine at the end of the sound as it reaches and passes the vocal cords, the withdrawal of the laryngeal sound and the passage of the tracheal catheter for injection of the opaque medium *are all done under fluoroscopic visualization* of the larynx and trachea.

The article has one drawing and three roentgenograms reproduced showing the stages of anesthetization and catheterization as detailed in the description of this method.—*W. M. Loehr, M.D.*

Auerbach, O. Tuberculosis of the trachea and major bronchi. *Am. Rev. Tuberc.*, Nov., 1949, *60*, 604–620.

Study of the trachea and major bronchi in 1,000 consecutive autopsies on tuberculous patients revealed 421 cases in which there was evidence of tracheobronchial tuberculosis. In 222 cases there was gross ulceration of the mucosa; 187 showed only microscopic foci in the walls of the air passages; in 12 there was no definite pulmonary lesion, but involvement of the bronchi secondary to rupture of a tuberculous regional lymph node into the tracheobronchial tree. Usually the patients had suffered from an extensive and progressive pulmonary tuberculosis.

The earliest type of involvement was represented by the microscopic foci in the subepithelial areas of the trachea and bronchi. These areas eventually caused ulceration of the epithelium either by pressure atrophy or by extension of caseation. Commonly there appeared

to have been extension of the ulcerative process from an involved bronchus on one side to the trachea and then on to the opposite bronchus. The ulcers occurred mainly on the posterior wall of the bronchi or trachea, and developed at any level in the tracheobronchial tree, but showed a definite predilection for the region of the carina—evidence that the spread is by direct passage of the organisms over the mucosa. In each of the cases with grossly evident ulcers, cavities were present in the lungs and in cases where only one major bronchus was involved the cavities were always present on the side of the involved bronchus. In most instances the ulcers were superficial and caused no thickening of the wall of the bronchus or trachea. Occasionally, however, the ulcerative process and the healing changes in the wall were so extensive that they caused a marked narrowing of the lumen. In the 6 cases of bronchial stenosis, the lung on the affected side was contracted and there was no evidence of pulmonary suppuration or of abscess formation beyond the obstruction.

In 85 per cent of the 421 cases there were associated tuberculous lesions in the larynx and/or intestinal tract.

There is no reference in this paper to the roentgenologic aspects of this problem.—*H. Fulton. M.D.*

Van Hazel, W., Holinger, P. H., and Jensik, R. J. Adenoma and cylindroma of the bronchus. *Dis. of Chest*, Aug., 1949, *16*, 146–168.

Twenty cases of adenoma and 2 cases of cylindroma are presented and analyzed in detail as to history, clinical, roentgen and bronchoscopic findings.

Of the adenomas, 14 cases were in females, with ages ranging from twenty-five to sixty-three, but mostly in the fourth decade. Hemoptysis occurred in at least 80 per cent with secondary signs and symptoms as bronchial obstruction became complete. All 22 cases had roentgen findings with 17 showing frank atelectasis, and the remaining 5 revealing "densities."

The authors state the origin of all these tumors is to be found within the major bronchi, probably arising from the serous or mucinous glands. They attempt to untangle the nomenclature by stressing the clinical and pathologic differences between bronchial adenomas and cylindromas. The adenomas have a broad base of attachment, are slowly growing, sometimes are dumb-bell in growth through the bronchial wall, and all have benign histopathological appearances. On the other hand, the cylindromas are an active invading malignant tumor, which in one case metastasized to the kidney. Both histopathologically and clinically the cylindroma represents a malignant bronchial neoplasm.

The authors give detailed surgical and bronchoscopic procedures which were used for treatment of these cases.—*F. R. Gilmore, M.D.*

Lett, James E., and Dietz, M. Wendell. Bronchography in the severely discharging lung. *Bull. Johns Hopkins Hosp.*, Aug., 1949, *85*, 135–137.

Adequate bronchography in the patient who expectorates 400 cc. of secretion or more daily is a problem. These secretions prevent good anesthesia due to lack of contact of the local agent with the bronchial walls. Likewise opacification of the secretion filled bronchi is not achieved. A technique was devised to try to overcome this problem. After the upper air passages were anesthetized a thin plastic endotracheal tube was passed under mirror vision into the trachea well above the carina. A long catheter was then inserted through the lumen of this tube and both sides of the bronchial tree were aspirated. Tenacious secretions were flushed out with small quantities of saline. The aspirated lower bronchial tree was then anesthetized with dilute pontocaine. Through the endotracheal tube the oil catheter could be readily introduced. To reduce coughing the tube was left in place until the examination was completed. All the cases studied were subjected to bronchoscopy and postural drainage previous to bronchography. By this method disease was found in several patients after all other methods failed to adequately demonstrate the bronchial tree.—*J. J. Wiesner, M.D.*

Storrs, Richard P., McDonald, John R., and Good, C. Allen. Lipoid granuloma of the lung following bronchography with iodized oil. *J. Thoracic Surg.*, Aug., 1949, *18*, 561–568.

The authors report a case in which at operation three weeks after bronchography with iodochlorol (iodized and chlorinated peanut oil) a granulomatous process was found in the lung, apparently caused by the iodized oil. In reviewing the literature only 3 similar cases were found.

The cases discussed showed a considerable

amount of iodized oil remaining in both lungs: a particularly large collection of oil visible in the areas corresponding to the location of the granulomatous lesions.

Studies with animals, using various iodized oils, have indicated that there is usually little reaction of the lung to these substances, but investigators have reported finding masses of epithelioid cells which had destroyed the normal pulmonary architecture in some regions. This is similar to the reaction observed in this case. One must conclude that the pulmonary tissue of this patient reacted in a different manner to contact with iodized peanut oil than does the pulmonary tissue of the average person. The authors state that peanut oil apparently is as good a base as the other oils currently in use.

The clinical importance of the reaction in this case was an apparent reduction of the patient's pulmonary reserve, requiring the use of oxygen therapy. The process, however, was a reversible one and the outcome satisfactory. It would seem most desirable to empty the bronchial tree of iodized oil as quickly and completely as possible after bronchography. In addition, it would seem advisable to make roentgengrams of the chest prior to surgical intervention in all cases in which bronchography has been performed and to delay surgery in those cases in which any considerable amount of residual iodized oil is observed.—*F. M. Reis, M.D.*

Jacobson, George, Denlinger, Ross B., and Carter, Ray A. Roentgen manifestations of Q fever. *Radiology*, Nov., 1949, *53*, 739–749.

This report is based upon the roentgenograms of the chest of 77 patients suffering from Q fever.

The causative agent is a rickettsia, which is a gram-negative rod which is resistant to drying, chemicals, and heat. It passes through Berkefeld filters. The organism has its chief reservoir in cattle and has been found in more than half the unpastuerized milk specimens tested in Los Angeles County. The exact mode of transmission is unknown. A high percentage of cases occurred in meat packers, dairy workers or laboratory workers.

The clinical features are those of atypical pneumonia and 50 per cent of the cases were so diagnosed initially. Meningism of a transitory character occurs in one-fourth of the cases. Fever ranges from 101 to 104° F. and lasts seven to fifteen days. Antibiotics are not effective.

The roentgen findings in the lungs were segmental or lobular consolidation in 43 cases and lobar consolidation in 16. Mottled confluent infiltration occurred in 6 cases and scattered patchy infiltration in 3. Twenty-four per cent of the cases had involvement of multiple lobes. However, migratory infiltration so often seen in atypical and virus pneumonia is not a feature of Q fever. A few cases showed a minimal amount of pleural fluid.

The diagnosis can be made only by finding the causative organism in the blood or by demonstration on successive examinations of the blood of a rising Q fever complement-fixation titer. The most characteristic roentgen finding is a homogeneous segmental or lobar consolidation. The lung findings closely resemble those seen in pneumococcic pneumonia.—*J. H. Harris, M.D.*

Weiss, A. G., Schmidt, C., Witz, J., Hollender, L., and Koebele, F. Intérêt de l'angiocardiographie dans l'étude des tumeurs thoraciques. (Interest in the use of angiocardiography for investigation of thoracic tumors.) *Presse méd.*, Dec. 25, 1949, *57*, 1189–1191.

The authors emphasize that, in addition to the use of this new procedure in the study of congenital heart lesions, angiocardiography can be very helpful in the diagnosis of thoracic tumors and their evaluation before operation. In malignant tumors of the lung, changes in the pulmonary artery or its branches may be observed such as distortions, more or less marked pressure and certain characteristic obstructions. Furthermore the method permits the demonstration of certain atypical vascularizations, when present enabling the ready detection of processes extending toward the hilus and mediastinum.

Angiocardiography is a valuable aid to the surgeon by allowing him to consider the possibility of performing ligatures on various vascular trunks. It enables the surgeon to outline the mediastinal tumors by noting the displacement or compression of these vascular trunks. It permits the precise diagnosis of a vascular aneurysm. In addition, it enables or permits the surgeon to assess pulmonary function by observation of intrapulmonary vascularization.

The authors conclude with the statement that

angiocardiography, without replacing bronchoscopy and bronchography, is a helpful means of investigation in surgical thoracic lesions.—*W. M. Loehr, M.D.*

Petersen, A. B., Hunter, W. C., and Sneedden, V. D. Histological study of five minute pulmonary neoplasms believed to represent early bronchogenic carcinoma. *Cancer*, Nov., 1949, *2*, 991–1004.

The authors point out that despite intensive studies, the actual histogenesis of bronchogenic carcinoma has rarely been observed. Five cases of minute lesions discovered at autopsy are presented along with a sixth case of a patient with a 2 by 3 cm. lesion demonstrable roentgenographically, but presenting a similar histopathologic picture. The theories of origin of the various types of carcinoma of the lung are reviewed. The authors favor the assignment of a bronchogenic origin for at least the majority of primary lung carcinomas because of the presence in the bronchus of a cell layer capable of giving rise to the cells usually considered to be the precursors of the three types of neoplasm encountered: (1) undifferentiated carcinoma, (2) adenocarcinoma, and (3) squamous cell carcinoma.

Of the 5 examples studied, all involved quite small bronchi. Four of the five minute lesions were in women, ranging from fifty-two to seventy years of age. The evidence favors the bronchial epithelium as the site of origin rather than the alveolar cells.—*P. B. Lockhart, M.D.*

Smith, R. R., Knudtson, K. P., and Watson, W. L. Terminal bronchiolar or "alveolar cell" cancer of the lung. *Cancer*, Nov., 1949, *2*, 972–990.

The report is based upon the study of 20 cases of terminal bronchiolar carcinoma found in the past twenty years at Memorial Hospital, New York. The symptoms and clinical findings do not differ greatly from the remaining 1,200 cases diagnosed clinically as cancer of the lung. Chest pain and cough were present in 65 per cent, while 3 cases were discovered on routine chest roentgenographic study. The remaining cases had symptoms of generalized disease such as Hodgkin's. The average age was 50.4 years and one-fourth were women. Occupation and family history of cancer were not significant. Only 4 patients were heavy smokers, but 10 gave a history of prior lung disease.

On physical examination, no objective evidence of tumor was found in 9 cases. Chest disease was indicated in 8 cases while 2 patients had palpable skin metastasis and 1 patient was terminal but had no physical signs of neoplasm.

In all cases there were abnormal shadows on the roentgenograms of the lungs. Characteristically, a single nodule differing from the usual metastatic nodule, in that it appeared more irregular, larger, less homogeneous, less sharply outlined and in many instances, less dense was found peripherally. Five cases showed multiple nodules. Although this disease does not produce a characteristically diagnostic roentgenogram the tentative diagnosis of a malignant tumor was made in 65 per cent from the film.

The diagnosis in most instances was made by aspiration biopsy of the mass either at the time of exploratory thoracotomy or preoperatively under fluoroscopic control. In 5 instances Papanicolaou smears of sputum or bronchial washing led to the diagnosis.

The distinguishing feature of this disease is seen in its gross and microscopic appearance and considerable space is given in describing these. In this series of cases, 65 of the cases were grossly nodular and 35 per cent were the diffuse form.

Palliative radiation therapy was given to 5 patients and was of little value. Two of the 9 patients who were operated upon are alive and well five years. The authors advise a study and trial of a combination of surgery and irradiation in which the primary disease is excised and interstitial radon is placed in the remaining inoperable cancer.—*D. C. Gastineau, M.D.*

Lowell, Lawrence M., and Tuhy, John E. Primary chondrosarcoma of the lung. *J. Thoracic Surg.*, Aug., 1949, *18*, 476–483.

Primary chondrosarcoma in the lung is exceedingly rare, only one other case having been reported in the literature. The symptoms and signs in this forty-one year-old female were chiefly of a cardiac nature. The roentgenogram of the chest showed a cor pulmonale or small density in the left lung adjacent to the mediastinum in the left upper lung and a larger mass behind the left ventricle. An electrocardiogram showed right axis deviation. Bronchoscopy showed posterior displacement of the left main bronchus and its divisions. Later on, the right hilar shadow also became enlarged, frank right heart failure supervened and the patient died before surgery could be undertaken.

Autopsy revealed right ventricular hyper-

trophy and a tumor on the medial surface of the left lung which extended into and almost filled the left pulmonary artery, the main pulmonary artery and some branches of the right pulmonary artery. No connection could be made out between the tumor and a bronchus. The microscopic picture was that of a chondrosarcoma. Other tumors of cartilaginous origin in the lungs are metastatic chondrosarcoma and hamartomas. A discussion of the factors concerned in the pathologic diagnosis is given. This case is unique because the tumor filled both pulmonary arteries. The exact origin of the tumor could not be ascertained.—*F. M. Reis, M.D.*

Râmniceanu, R., and Paunesco-Podeanu, A. La pathologie tardive du poumon traumatisé. (Documents clinico-radiologique.) (Delayed pathology of the wounded lung; clinico-roentgenologic case records.) *Presse méd.*, Dec. 31, 1949, *57*, 1251–1252.

The paper concerns the delayed post-traumatic manifestations following wounds of the lung, particularly war wounds from shell and shrapnel. Whatever fibrous or angiosclerotic cicatricial sequelae follow, such wounds are constantly submitted to the motion of the respiratory mechanism, that is to a functional traumatism of some degree. The prognosis of these pulmonary sequelae should be guarded as delayed complications are always possible such as septic and hemorrhagic accidents occurring as the result of some physical effort or some intercurrent infection, or even spontaneously in apparent full health. Furthermore, the thoracopulmonary scar by itself may be harmful since it can, in the long run, compromise the respiratory function and the right heart. The authors report 15 cases as examples of such delayed pathology.—*W. M. Loehr, M.D.*

Touroff, A. S. W. and Sapin, S. O. Solitary intrathoracic neurofibroma. *Surgery*, Nov., 1949, *26*, 787–798.

The authors report 2 cases of solitary intrathoracic neurofibroma because of the unusual locations of these tumors. There is a brief review of the literature on the subject. Approximately 180 such cases have been recorded.

These neoplasms have been divided into two groups each of which represents a different concept of histogenesis. Those of the first group are said to include both neural and connective tissue elements and probably arise from the Schwann cells. They are therefore, according to Stout, ectodermal in origin. Those of the second group are said to arise from elements of the sympathetic nervous system. According to the authors' analysis of the literature, neurofibromas and ganglioneuromas have been reported in almost equal numbers. The incidence of malignant change as reported by different authors is between 10 and 37 per cent of cases. Stout is stated to have said that the solitary neurofibromas are not malignant. In general, it would appear that the incidence of malignancy is significant.

A large majority of these tumors arise from elements within or very close to the posterior mediastinum. The hour-glass or dumb-bell varieties lie partly within or near the spinal canal.

The authors' first case is that of a thirty-nine year old woman who had a mass at the level of the third to fifth ribs in the axillary portion of the right chest which was discovered on routine roentgenologic examination. The mass had a smooth, well defined contour, a uniform density and measured approximately $2\frac{1}{2}$ by $1\frac{1}{2}$ inches is size. Exploration of the thorax was performed and the tumor was removed. The pathologic microscopic diagnosis was neurofibroma.

The second case is that of a young man eighteen years of age. A routine roentgenogram of the thorax revealed a rounded, smooth, well circumscribed mass that measured 2 by 2 by 3 inches in size and was located at the level of and just posterior to the right hilus. Moderate vascular congestion was present in the right lung. There was no change in the appearance of the lesion after a trial of roentgen therapy. At operation the mass was found to be well encapsulated and was located within the substance of the upper portion of the right lower lobe. The microscopic pathologic diagnosis was that of neurofibroma.

Neither patient had complained of symptoms preceding the diagnosis of intrathoracic tumor after roentgenologic examination. Subsequent to the diagnoses there were some subjective symptoms. Symptoms and physical signs usually are not present unless the tumor is large, has undergone malignant change, or causes compression of neural elements in the spinal axis. Almost all such lesions are discovered during routine roentgenologic examination of the chest. All authors agree that the proper treatment is removal by surgery.—*C. B. Holman, M.D.*

Vass, A., and Mack, J. Keller. Drainage of pulmonary veins into coronary sinus. *Am. J. Dis. Child.*, Dec., 1949, *78*, 906–913.

Anomalous drainage of all the pulmonary veins into the right side of the heart is rare. When this anomaly is present, the right side of the heart is called upon to transport a greatly increased volume of blood and the left side a much diminished volume. This is shown in all the 7 cases reported in the literature by the hypertrophy of the right side and the relative atrophy of the left. In all the cases the foramen ovale was open though in 4 cases it was reported to be only a slit. In but 1 case was there a patent ductus arteriosus. As the foramen ovale becomes smaller, the load on the right side of the heart increases, the circulation becomes more unbalanced and decompensation ensues. It is obvious that when both pulmonary and systemic veins drain into the right atrium abnormal communications between the right and left sides of the heart must be present in order that the condition be compatible with life. Of the cases described, death occurred in 1 at two years of age and in all others by the age of 6 months.

In the case reported the roentgenogram showed a large heart of globular shape. At postmortem, the principal anatomic diagnoses were: (1) drainage of the pulmonary veins into the right atrium (coronary sinus), with a patent foramen ovale constituting the only connection between systemic and pulmonary circulations; (2) a bicuspid tricuspid valve; (3) hypertrophy and dilatation of the right side of the heart; (4) chronic passive hyperemia of the lungs and other organs; and (5) terminal verrucous endocarditis of the tricuspid and mitral valves.

The authors were unable to find in the literature a case diagnosed during life which was proved at autopsy. Their patient lived relatively long, but a complete study of the heart was impossible because the parents would not permit it. They suggest a possible embryonal development mechanism of the malformation which they describe in detail.—*R. S. Bromer, M.D.*

Boone, Bert R., Ellinger, George F., and Gillick, Frederick G. Electrokymography of the heart and great vessels: principles and application. *Ann. Int. Med.*, Dec., 1949, *31*, 1030–1056.

The electrokymograph is an instrument which permits the graphic registration of the movements of the heart and great vessels. It was specifically designed as an attachment for use with the roentgenoscope and electrocardiograph. When these three units are utilized together, for the purposes of electrokymography, the basic function of each is as follows: the roentgenoscope provides the means for observing the cardiovascular silhouette of a subject and for positioning the electrokymographic pick-up unit over a selected area; the electrokymograph converts the motions and density changes of such selected points to corresponding current variations; and the electrocardiographic galvanometer records these variations on moving bromide paper (an electrokymogram). A carotid sphygmogram is simultaneously recorded for timing and orientation purposes.

This paper summarizes observations made to date, in the electrokymograms of a large group of normal individuals, and indicates some of the significant variations noted in patients with cardiovascular disease. It is well illustrated with numerous electrokymograms of various portions of the heart and the great vessels, and a detailed discussion is given concerning the physical characteristics, common to all electrokymograms, as well as the records from specific chambers of the heart and major vessels.

It is the authors' opinion that the instrument provides a valuable aid for studying the physiology of the cardiovascular system in human subjects and it warrants continuing evaluation of its possible clinical application. Promising results have been obtained in preliminary studies of the arrhythmias and myocardial infarcts such as presented here. It is of interest to note the striking similarity between the ventricular electrokymogram found in some human subjects with myocardial infarcts and the ventricular myogram obtained by Tennant and Wiggers (*Am. J. Physiol.*, 1935), after they produced experimental infarction in dogs. Both demonstrate clearly "paradoxical" movement of the infarcted ventricular wall. In examinations being done on a large group of older men, the authors encountered several instances of paradoxical type movement in subjects with no, or minimal, cardiovascular symptoms and a normal electrocardiogram. Records from subjects with valvular heart lesions have been difficult to analyze.—*K. K. Latteier, M.D.*

Lewis, J. L., Jr., and Terry, Luther L. Electrokymography—An appraisal of its present clinical status. *Ann. Int. Med.*, Jan., 1950, *32*, 36–51.

In essence, electrokymography is a method of recording the pulsating motions exhibited by the heart and great vessels. A photosensitive tube is used to pick up variations in the light emitted by a fluoroscopic screen placed over the border of the cardiovascular stripe.

The electrokymograph is explained in considerable detail and there are illustrative diagrams of the apparatus. The instrument records the motions of the borders of the heart and great vessels. The photoelectric pick-up tube is mounted behind a small square bit of fluoroscopic screen. There is a small slit in the pick-up tube housing which is placed halfway over the border of the cardiac silhouette and in such a position that the long axis of the slit is approximately perpendicular to the edge of the cardiovascular silhouette. In this manner, tracings can be taken from as many points as desired along the cardiac silhouette. In general, ten recordings of various positions are made in five or six minutes with the patient receiving an average total exposure from 50 to 100 r, limited to a small skin area. The roentgenoscope may be run at standard milliampere and kilovolt settings. The authors were able to obtain satisfactory tracings in most patients with as little as 2 to 3 ma. and 85 kv. and 10 r or less per minute, incident upon a small changing skin area.

As compared with the roentgen kymogram, which shows the outline of the heart and great vessels, together with wave forms representing pulsations occurring in multiple areas, the electrokymogram records the motions occurring at a single area at one time, without relative comparison possible between the amplitude of pulsation at different points in the silhouette. The great advantage of the latter is that a clear large wave form is obtained coupled with a more precise timing which often permits ready, sharp identification and differentiation of the events occurring during various phases of the cardiac cycle.

A representative cardiac cycle is given in diagram. The waves have a characteristic form for each of the various chambers or segments of the heart and great vessels, with minor variations depending upon the angle of view or rotation at which the tracings are taken. Any motion of the patient, movement of the phototube or fluoroscopic screen will introduce artefacts into the tracings. Variation from the normal wave form may be due to (1) disturbance of rhythm; (2) intrinsic muscle changes; (3) extracardiac influences and (4) valvular defects. The authors state that the determination of the cardiac mechanism from study of the electrokymogram is at best an approximation since only a single area can be recorded at one time. Ordinarily, there is no simultaneous recording of the auricular and ventricular events, and those recorded are mechanical rather than electrical. Sinus rhythm is suspected if the cycles are regular at a normal rate and if normal auricular tracings are obtained. Ectopic beats may be demonstrated, and auricular fibrillation is easily spotted by the irregularity and varying amplitude of the wave forms from cycle to cycle. Auricular flutter generally produces satisfactory auricular waves which are quite striking. Arteriovenous block can also be demonstrated. The authors state that, while it appears probable that intrinsic muscle changes may cause deviation of wave form from normal, much work on the subject remains to be done. Individuals without apparent rhythm disturbances, abnormal extracardial influences or apparent valvular defects do show definitely abnormal wave forms. Many of these are individuals who present evidence of having myocardial infarction, recent or remote; but a few individuals who show localized wave form abnormalities do not. In myocardial infarction, the results are equivocal. Of 6 cases of posterior and basal myocardial infarction, only one kymogram was judged compatible with the diagnosis. Of 13 cases of apical and anterior infarction, 7 were considered compatible with the diagnosis.

It is felt by the authors that the electrokymograph, at the present time, and in the present state of development, is a physiological research tool. It is for the clinical investigator rather than for the clinician. It may be of diagnostic value in a select group of patients when used with discretion. There are numerous curves, tracings and one table and there is a large bibliography.—*J. G. Snead, M.D.*

Gavey, C. J. The cardiology of old age. *Lancet*, Oct., 1949, *2*, 725–736.

The author presents the results of study of 360 patients over the age of seventy years (34 over eighty years). The clinical, pathologic,

electrocardiographic, roentgenologic and therapeutic aspects of geriatric cardiology are emphasized.

Of the etiologic types of heart disease, hypertension and coronary disease were most common. The average blood pressure was 188/102, and two-thirds of the patients were hypertensive. Arteriosclerosis, while common, was less often found than generally thought, and the correlation between high blood pressure and arteriosclerosis was not constant. Congestive failure was present in 12.7 per cent of the subjects, but was amenable to the usual forms of therapy as in younger patients.

Electrocardiograms not uncommonly revealed a normal curve as judged by standards used for younger adults, suggesting that these standards remain correct for old age.

Roentgenologic studies showed that kyphoscoliosis was present in about one-half of the patients. The heart and aorta may appear the same as in younger persons, but this is the exception. The aorta is usually unfolded and dilated to a variable degree, which seems to be independent of the height of the blood pressure. It is common to find a large heart in hypertensives with a minimal degree of unfolding, and gross unfolding in non-hypertensives. The kyphosis allows a good view of the unfolded aorta in the left oblique position; the apex of the heart is often tilted upward by the rigid tortuous aorta.—*Harold Fulton, M.D.*

Peck, Dorothea R., and Wilson, Hugh M. Conventional roentgenography in the diagnosis of cardiovascular anomalies. *Radiology*, Oct., 1949, *53*, 479–487.

Investigation of all cases of cardiovascular abnormality by a team of physicians using the new diagnostic techniques designed to evaluate operability is impractical. Yet with recent advances in cardiovascular surgery, large numbers of possible candidates for surgery should be evaluated. Therefore, all roentgenologists must familiarize themselves with the diagnostic possibilities and limitations of conventional cardiovascular roentgenography in order that they may separate the inoperable and those readily recognizable as operable from those needing investigation by a skilled team.

The authors present, as an aid to rapid screening, a simple classification of cardiac malformations, based on the presence or absence of cyanosis and the roentgenographic appearance of the pulmonary artery segment of the left cardiac border. The diagnostic possibilities of each combination of findings are discussed and illustrated by case reports and reproductions of roentgenograms.—*George Cooper, Jr., M.D.*

Stauffer, Herbert M. The conventional roentgen examination in operable congenital heart disease. *Radiology*, Oct., 1949, *53*, 488–499.

Because cardiovascular surgery is preferably deferred until after infancy and because the great majority of the patients with serious, complex, and inoperable anomalies die during infancy, the practical problem of the roentgenologist is confined to the relatively few possibilities that occur with frequency after the age of two years.

The clinical and roentgen findings in these conditions are summarized. The roentgen findings, often atypical, usually serve to rule out rarer malformations which may not be suitable for surgery rather than to reach an exact anatomical diagnosis.

In the majority of cases a satisfactory diagnosis for purposes of prognosis and of selection of cases for surgery can be made by correlation of ordinary roentgenologic and clinical findings. For practical clinical purposes, angiocardiography and heart catheterization may be reserved for selected obscure cases.—*George Cooper, Jr., M.D.*

Thompson, W. H., Figley, M. M., and Hodges, F. J. Full cycle angiocardiography. *Radiology*, Nov., 1949, *53*, 729–738.

The essential factors for an adequate angiocardiogram are:

1. Individual exposures must be sufficiently brief to stop effectively the movement of cardiac walls and the advancing column of opacified blood. Exposures as rapid as one-sixtieth of a second are desirable; exposures which exceed one-twentieth of a second approach the allowable maxim.

2. Ability to provide multiple exposures in extremely rapid sequence is necessary if the entire cycle of cardiac circulation is to be observed. Within the beating heart, events occur so rapidly that an exposure rate of four per second may well be considered to be a minimum requirement.

3. Roentgenographic images must be brilliant and clearly detailed if they are to be in-

terpreted with the degree of accuracy which examination of this type requires.

4. Apparatus used for angiocardiography must be automatic and dependable in operation. A rapid burst of automatically timed and spaced exposures is required to record the fleeting circulation of the opaque mass from vena cava to descending aorta.

At the University of Michigan a Cinex camera is used capable of making 2½ exposures per second at 1/20 of a second exposure.

Films of 6 patients are used to demonstrate the necessity for rapid serial exposures if all the chambers of the heart and great vessels leading to and from the heart are to be visualized.

A new Cinex camera is described which will make six exposures per second. This will be combined with a direct writing, two-channel oscillograph so that continuously recorded electrocardiographic tracings may be obtained. —*J. H. Harris, M.D.*

Lura', A., and Botti, G. D. Studio roentgenchimografico delle calcificazioni valvolari cardiache. (Roentgen kymographic study of cardiac valvular calcifications.) *Radiol. med.*, Nov., 1949, *35*, 859–876.

The anatomical site of cardiac calcification has been determined roentgenologically, not only by its localization and shape but also by its motion as related to the heart cycle.

In the past, investigators have used special methods for the study of valvular movements, kymography and cinematography, frequently in conjunction with electrocardiography.

The authors describe 2 cases of valvular calcification, the first, of the mitral valve, the second, of the aortic semilunar valves, studied by linear kymography, and by rotatory kymography as well as by other conventional methods.

In general during systole there is a rapid motion of the valvular calcification downward toward the apex of the heart, during diastole a lower opposite movement toward the base of the heart. These changes in position are due to the piston-like action of the atrial-ventricular septum. To these fundamental motions there is added the lateral excursion of the valvular leaflets.

Since the movements of the cusps and of the annulus fibrosus occur in different planes, the kymographic tracings obtained will vary from case to case and will depend not only on the location and extent of the valvular calcifications, but also on the degree of involvement of the annulus fibrosus.

The authors conclude that a careful analysis of the components of the kymographic registration of the motion of valvular calcifications will be of great diagnostic aid.—*A. A. Blasi, M.D.*

Seybold, William F., McDonald, John R., Clagett, O. Theron, and Harrington, Stuart W. Mediastinal tumors of blood vascular origin. *J. Thoracic Surg.*, Aug., 1949, *18*, 503–517.

This report deals with 3 surgical cases of mediastinal tumor in which the histopathologic picture was that of hemangioma or hemangio-endothelioma. These lesions were encountered among two hundred mediastinal tumors treated surgically at the Mayo Clinic. Mediastinal tumors of blood vascular origin are rare, only 14 additional cases having been found in the literature. The clinical aspect and behavior of the tumors are discussed and amply illustrated with reproductions of roentgenograms and photographs. Two of the three tumors presented were in the posterior mediastinum and were preoperatively diagnosed as neurofibromas. In 2 of the cases there was evidence of malignancy. One patient had a lesion that had invaded surrounding mediastinal structures and was too extensive for surgical removal; the other lesion was histopathologically of low grade malignancy and had invaded a contiguous sympathetic ganglion. The third patient had a benign hemangioma. Of the 14 cases mentioned in the literature there was evidence of malignancy in 8. Benign hemangiomas associated with metastatic tumors are really multiple primary lesions. The outlook for a patient with a benign hemangioma is probably excellent. The prognosis must be guarded in cases of a lesion with histopathologic features of malignancy.

No mediastinal tumor produces a sufficiently distinctive clinical or roentgenologic picture to permit a consistently accurate pathologic diagnosis. All these tumors should be removed surgically unless a definite contraindication exists.—*F. M. Reis, M.D.*

Kleitsch, W. P., Munger, A. D., and Johnson, W. F. Diaphragmatic hernia with complete evisceration of the liver. *Ann. Surg.*, Dec., 1949, *130*, 1079–1084.

The case presented is believed by the authors

to be the first diaphragmatic hernia which had as its contents the entire liver and gallbladder. Congenital herniations of the diaphragm are seen in childhood most frequently. Acquired and traumatic herniations are more common in adults. These three categories are classified on a clinical basis according to Hedblom.

The authors' case suffered severe injuries in an automobile accident 6½ years prior to the reported complications. When seen he had a speech defect and the residuals of a right hemiplegia. Following the accident he used an indwelling suprapubic catheter for about two years incident to a cystotomy necessitated by a fractured pelvis. The patient came to the hospital with the symptoms of urinary infection. This was proved by laboratory tests. A roentgenogram of the abdomen and intravenous pyelography disclosed a bilateral hydroureter and hydronephrosis with a large calculus in the right ureter and renal pelvis. A chest roentgenogram at this time revealed elevation of the right leaf of the diaphragm with a pleural reaction above it. A right renal pyelolithotomy was done and postoperatively the patient developed a cough, dyspnea and abdominal distention. Hyperresonance of the right hemithorax with absence of the breath sounds was determined. There were coarse, moist breath sounds over the left lung. The patient was thought to have postoperative atelectasis on the right. Chest and abdominal roentgenograms disclosed the colon to be in the right thoracic cavity. A thoracotomy was performed and the suspected diaphragmatic hernia was repaired after replacement of the liver, major portion of the transverse colon and hepatic flexure into the peritoneal cavity. His postoperative course was uneventful. Roentgenographic examination of the chest then revealed the right leaf of the diaphragm to be only slightly elevated and there was some increase in basilar markings.

The authors conclude that the absence of the liver shadows on the preoperative abdominal roentgenogram would have given a clue to the presence of the hernia. The symptoms of diaphragmatic hernia are usually those of gastrointestinal disturbances. Respiratory symptoms are secondary. The etiology of this hernia is indefinite but in view of the previous serious injury, trauma should receive first consideration. The possibility of its being congenital cannot be excluded.—*K. L. Krabbenhoft, M.D.*

Fracasso, E., and Gurian, G. Aspetti radiologici delle alterazioni periesofagee nelle stenosi da caustici. (Roentgen aspects of periesophageal changes in stenosis due to caustic substances.) *Radiol. med.*, Nov., 1949, *35*, 877–885.

The authors had observed that in 30 per cent of their cases of esophagitis following the ingestion of caustics the symptomatology indicated also a periesophageal involvement. This hypothesis was supported by the pathological findings in 5 patients who had succumbed to intercurrent diseases.

In these, numerous and deep changes of the periesophageal tissues were demonstrated, i.e. thickening of the esophageal wall; lymph node hypertrophy and softening; adhesions of the esophagus to the pleura and to neighboring structures.

The authors, in view of the paucity of the literature on this topic, attempt to establish roentgenological criteria for the diagnosis of periesophageal changes following chemical stricture.

A preliminary film examination of the mediastinum in the standard positions is followed by a contrast study. The most informative projections are the lateral and the right anterior oblique. The region limited posteriorly by vertebral column and anteriorly by cardiovascular shadows is the one which contains the trachea and the esophagus. In the normal cases the authors describe a vertical narrow opaque band in this region, which limits the trachea posteriorly and which has a thickness of 3 mm. to 5 mm., and which may be seen less distinctly for a short distance below the tracheal bifurcation.

This stria probably represents a summation of shadows, primarily the posterior tracheal wall, the esophagus and pleural reflections, as contrasted by pulmonary air shadows.

The authors studied 15 cases of chemical stricture of the esophagus, 14 involving the middle third, and 1 of the lower third.

They were able to demonstrate thickenings and irregularities of the paratracheal band in cases with suspected periesophageal changes. By comparison with contrast studies they were able to consider the relative extent of the involvement of the esophageal lumen and of the periesophageal tissues. By kymography they were able to investigate functional disturbances as well.

The authors conclude that valuable informa-

tion can be obtained by this method and that it can be extended to the study of all pathological processes of the esophagus.—*A. A. Blasi, M.D.*

JUTRAS, ALBERT, LEVRIER, PAUL, and LONGTIN MARCEL. Étude radiologique de l'oesophage para-diaphragmatic et du cardia (Roentgen study of the diaphragmatic esophagus and of the cardia.) *J. de radiol. et d'électrol.*, July–Aug., 1949, *30*, 373–416.

This paper (almost a monograph from the standpoint of length and completeness) was presented as the first communication at the VII Congress of French-speaking Radiologists in Paris, October 10–15, 1949, by Professor Jutras of Montreal, Canada, and his associates. The paper is a splendid presentation of the normal roentgen anatomy of the lower esophagus and the gastric cardia. Physiological considerations of importance in the examination of this region, technique and method of examination, and diagnostic criteria of all lesions to be met with in this area are discussed. The illustrative material in this article is excellent. —*W. M. Loehr, M.D.*

ABDOMEN

INGELFINGER, F. J., LOWELL, F. C., and FRANKLIN, Wm. Gastrointestinal allergy. *New England J. Med.*, Aug. 25, 1949, *241*, 303–340.

Gastrointestinal allergy is a diagnosis frequently entertained, occasionally evaluated, and rarely established. Experimental production in animals and man of gastrointestinal reaction due to contact of sensitized tissue with allergen has been established, but evidence for spontaneous occurrence of gastrointestinal allergy is inconclusive. There appear to be no manifestations pathognomonic of gastrointestinal allergy. Diagnostic methods commonly used are of doubtful value. The validity of skin tests and changes in blood element counts remains to be established.

Roentgen study of the gastrointestinal tract may reveal marked derangement of appearance and motility after ingestion of food, often interpreted as evidence of gastrointestinal allergy. However, in the absence of controls, one cannot be certain that observed changes are allergic rather than nonspecific. Action of suspected foods, given with barium, on gastric emptying time or on small bowel motility, is nonspecific in at least some cases. It has been well demonstrated that many foods, particularly those containing fat, delay gastric emptying time considerably. Milk may produce definite changes in tonicity, segmentation, and transport of barium through the small bowel, apparently in both non-allergic and allergic individuals. As Weber has stated, "In no field of roentgenologic diagnosis is the exercise of critical judgment and objectivity more necessary."—*H. P. Brean, M.D.*

SCHROEDER, C. MORRISON. Hourglass stomach caused by annular muscular hypertrophy. *Ann. Surg.*, Dec., 1949, *130*, 1085–1090.

Hypertrophic pyloric stenosis is most commonly seen in infants and occasionally in adults. In the case reported, an annular constriction was observed in the proximal portion of the gastric antrum. The patient had symptoms of an intermittent obstruction with no vomiting for one month. One such episode had occurred six years previously. The patient's blood serological reaction was positive in 1928 and he received treatment. The annular constriction was demonstrated roentgenologically and a freely movable translucent mass was seen proximal to the deformity. The former was thought to represent a gastric carcinoma; the latter, a foreign body or polypoid tumor.

A subtotal gastric resection was carried out. The pathological diagnosis was an annular constriction due to muscular hypertrophy, entirely restricted to the muscular layer. The lumen of the stomach at that point was only 1 cm. in diameter. The translucent mass was found to be a peach pit, which probably had precipitated the rapid onset of symptoms. The mucosa of the stomach was intact. Hourglass deformity of the stomach is usually the result of an intrinsic ulcerative benign process. Syphilis and carcinoma may also produce this deformity. In this case, a benign muscular hypertrophy, unusual in location, was thought to be a malignancy.—*K. L. Krabbenhoft, M. D.*

CAMPBELL, R. J. C. Gastric adenomyosis; report of a case. *Brit. J. Radiol.*, May, 1949, *22*, 284–285.

A rounded filling defect in the prepyloric region of the stomach of a thirty-seven year old woman with a vague history of indigestion is described and illustrated. The roentgenographic impression was benign tumor of the stomach. Partial gastrectomy was performed

and the specimen revealed a small firm mass in the wall of the stomach. On the mucosa above the lesion was a small diverticulum leading into the mass, and this was lined by gastric mucosa. Below the gastric glands was a group of glands of the pancreatic type.

Gastric adenomyosis is a congenital heterotopia which probably has its origin in epithelial buds which develop as diverticula and become incorporated in the wall of the gut. They are analogous with the epithelial buds which form the early pancreas. Roentgenologically the lesion is important because of its resemblance to peptic ulceration.—*Harold Fulton, M.D.*

Elkeles, A. Radiological studies of the abdominal aorta in individuals over 50 as an aid to the differential diagnosis between benign and malignant ulceration of the stomach. *Brit. J. Radiol.*, May, 1949, *22*, 280–283.

Gastric ulcer and gastric carcinoma are predominantly diseases of middle-aged and elderly people and in this age group arteriosclerotic changes become prominent. The abdominal aorta was chosen by the author for study since the stomach derives its blood supply from the celiac axis, a branch of the abdominal aorta. According to statistical observations the abdominal aorta is most frequently and extensively involved in generalized arteriosclerosis.

Bucky films were exposed with the patient in the right oblique and the centering was controlled fluoroscopically. On the films the degree of calcification of the abdominal aorta was graded from zero to three plus. In 184 persons over fifty years of age, gastric ulcers showed by far the highest incidence of calcification of the abdominal aorta (69.4 per cent of 36 cases), whereas its almost complete absence in gastric carcinoma was striking (1 of 32 cases).

It is suggested that the pathogenesis of peptic ulceration in individuals past middle age is analogous to that of coronary or cerebral thrombosis. Vascular occlusion due to arteriosclerosis is the commonly accepted cause for these conditions in middle-aged and elderly people, and it is feasible to assume that the same pathological process in gastric vessels is responsible for the development of peptic ulceration in advancing years. Apparently the same factor does not influence the development of gastric carcinoma.—*Harold Fulton, M.D.*

Wellens, P., and Spyckerelle, G. Le prolapsus de la muqueuse gastrique à travers le pylore, syndrome souvent méconnu et son aspect radiologique. (Prolapse of the gastric mucosa through the pylorus, a syndrome often unrecognized, and its radiological aspect.) *J. belge radiol.*, Sept., 1949, *32*, 157–169.

The authors report an incidence of prolapse of the gastric mucosa in 5 per cent of 261 gastrointestinal roentgen examinations in their practice. This is a higher incidence than has been recently reported by American authors (1 to 3 per cent). In this condition laxity of connective tissue and abnormal peristalsis must be present. The diagnosis can only be made roentgenologically. The characteristic finding is a central defect in the duodenal bulb, creating an appearance described as mushroom or cauliflower defect. Often the contours of the prolapsed folds can be followed from the antrum into the bulb.

A case is described in which the roentgen findings were characteristic. Laparotomy allowed palpation of a soft tumor in the duodenal bulb. Gastrectomy was done and the prolapsed mucosa showed chronic inflammation and edema.—*Norman Simon, M.D.*

Haworth, James B., and Rawls, Noel B. Prepyloric local gastritis. *Radiology*, Nov., 1949, *53*, 720–728.

Spasm and mucosal deformity in the prepyloric segment of the stomach are common. In a series of 1,519 upper gastrointestinal studies 22.1 per cent of the cases showed prepyloric local gastritis. Slightly more than one-third of these cases were without demonstrable peptic ulcer.

The authors feel that prepyloric local gastritis is primarily a psychosomatic disorder in which the parasympathetic nervous system is subjected to excessive stimulation of central origin. They also believe that the disease is a precursor of peptic ulcers.

Symptoms are similar to those of peptic ulcer. In 12 per cent of the cases without peptic ulcer, gastrointestinal bleeding was present.

Histologic sections show infiltration of the mucosa with lymphocytes, plus capillary hemorrhage. Edema of the submucosal connective tissue is also a frequent finding.

Roentgenographically these are the diagnostic criteria: presence of an initial gastric fluid residue; visible prepyloric mucosal de-

formity; localized tenderness; spasm along the distal portion of the lesser curvature—with or without pylorospasm; interference with normal peristalsis and "antral systole."

Treatment is similar to that of peptic ulcer. In addition "pyribenzamine" is administered. —*F. B. Markunas, M..D.*

Benassi, Enrico, Un aspetto radiologico non raro dell'ulcera duodenale: la nicchia bulbare "a cupolino." (The roentgen appearance of a type of duodenal ulcer described as dome shaped.) *Ann. radiol. diag.*, 1949, *21*, 366–377.

The author describes a type of duodenal ulcer in which the niche is seen as a nipple-like or dome-shaped opacity projecting from the central area of the base of the cap while the distal part of the bulb is empty due to spasm. This lesion is best seen in prone films tending to disappear on oblique or lateral projections. Compression does not help in demonstrating this type of niche. Surgical specimens of such cases showed a deep chronic ulcer near the pyloric canal but no scarring or fixed deformity of the cap. This ulcer may on later examinations assume a marginal or stellate configuration; the reverse also is true.

Occasionally, prolapse of the gastric mucosa into the duodenal base produces a somewhat similar appearance.—*C. Colangelo, M.D.*

Hawthorne, H. R., and Frobese, A. S. Chronic stenosing regional enteritis; surgical pathology and experience in surgical treatment. *Ann. Surg.*, Aug., 1949, *130*, 233–241.

The authors present their experience in the surgical treatment of 30 cases of regional enteritis. The series includes regional duodenitis, jejuno-ileitis, terminal ileitis, ileal colitis and regional colitis. They believe that the lesions at the various sites in the intestinal tract are manifestations of the same disease. Ulcerative colitis is considered a different disease clinically and pathologically. Regional enteritis is classified into three phases: the acute, the chronic and the chronic with complications. The writers give an excellent description of the gross pathology in these phases and include the associated microscopic findings of Hadfield. Resection is rarely attempted during the acute phase. In the chronic phase the complicating features of obstruction, peritonitis, abscess formation or a fistula may be present. The surgical management of the chronic phase consists of resection of the diseased bowel and primary anastomosis or short-circuiting the involved area by division of the bowel above the lesion and anastomosis of the normal ileum to the colon. In this series because of the high percentage of recurrence, in spite of wide resection, the authors believe that surgical procedures should be confined to those cases with complications. They also advocate the use of less radical procedures such as ileostomy, or short-circuiting operations without resection.—*T. D. Allison, M.D.*

Levy, Silvio. Aspectos radiológicos das oclusões intestinais. (Roentgenologic aspects of intestinal occlusions.) *Rev. brasil de gastroenterol.*, Nov.–Dec., 1949, *1*, 573–593.

While the importance of the roentgen examination for the early and accurate diagnosis of intestinal obstruction is undisputed, it must be emphasized that such examination should not be used as a substitute for a careful clinical examination and that the best results depend on a close correlation of the clinical and roentgen findings.

From a clinicopathological viewpoint, three types of intestinal occulsion are considered: (1) mechanical (simple, loop formation without strangulation, and strangulation), (2) functional (peritonitic and non-peritonitic), and (3) vascular obstruction. As roentgen diagnostic methods of definite value are discussed: (1) plain roentgenography of the abdomen at different times and in different positions of the patient, (2) examination by means of barium enema, and (3) examination after instillation of contrast medium into the small intestine through a Miller-Abbot tube.

Simple (plain) roentgenography should always be done as a preliminary measure. In many cases it will give valuable data regarding the presence, location, type and probable cause of obstruction. Distention of the small intestine may be demonstrable roentgenologically before it can be demonstrated clinically. In mechanical ileus there is distention of the loops proximal to the obstruction while the loops distal to the obstructed area may still show peristalsis. If the obstruction is localized in the colon, distention of the small intestine is inconstant and depends on the continence or incontinence of the ileocecal valve. In strangulation, in addition to distention of the lumen proximal to the obstruction, signs of vascular damage may be present ("horseshoe" looping, thickening of the borders or "bordure de deuil," decreased

translucency of the intestinal loops or even spontaneous visualization). Intestinal infarct by mesenteric thrombosis produces similar roentgen signs.

In adynamic ileus signs of peritoneal fluid may be seen. If the exudate is diffuse, the distention may involve the small intestine and the colon. However, there are cases of regional symptomatic ileus in which, due to localized peritoneal reaction, intestinal segments, which are topographically adjoining but anatomically non-contiguous, are dilated and, according to pathologic cause and affected organ, present a more or less characteristic aspect.

Roentgenograms of several cases in which the roentgen diagnosis was confirmed by operation or autopsy illustrate the different types of intestinal obstruction.—*E. A. Schmidt, M.D.*

Felson, Benjamin. Appendical calculi; incidence and clinical significance. *Surgery*, May, 1949, *25*, 734–737.

The author recalls that in 90 per cent of 100 published cases appendical calculi were associated with acute appendictis. Perforation occurred in almost 50 per cent of cases. This report concerns the actual incidence of calculi in acutely diseased and normal appendices.

Calculi were present in 33 per cent of 75 acutely inflamed appendices and in only 2.7 per cent of 183 normal specimens. Calculi were graded with respect to their roentgenologic characteristics, and the author estimated that in at least 9 of 25 cases of acute appendicitis the shadows of the calculi should have been visible in good quality roentgenograms of the abdomen. Calculi may have been detected roentgenologically in 2 of the 5 instances of normal appendices.

The author concludes that a large majority of patients who have appendical calculi visible roentgenologically have acute appendicitis, and that the incidence of perforation is high. The shadow of a laminated calculus in the right lower abdominal quadrant in close proximity to the outline of the gas filled cecum is presumptive evidence of appendical stone. The diagnosis is almost certain if the patient has acute symptoms referable to the lower part of the abdomen, in addition to these roentgenologic manifestations, and immediate surgical intervention is indicated.—*C. B. Holman, M.D.*

Pearson, C. M., and Fitzgerald, P. J. Carcinoid tumors—a re-emphasis of their malignant nature. *Cancer*. Nov., 1949, *2*, 1005–1026.

The authors present an excellent review of the subject and include 140 cases of their own from the files of the Mallory Institute of Pathology. Ninety-eight of these (70 per cent) occurred in the appendix and 42 (30 per cent) were non-appendiceal in origin. None of those originating in appendix showed evidence of regional node or distant involvement, while 38 per cent of the non-appendiceal group were found to have metastasis.

Intermittent episodes of small bowel obstruction associated with abdominal pain, diarrhea and weight loss are the most common signs and symptoms. Roentgenologically, kinking of the small bowel in the absence of tumor mass is suggestive of carcinoid. In the appendiceal carcinoids the signs and symptoms are usually those of appendicitis.

Because of the high incidence of metastatic lesions in carcinoid tumors, especially in the non-appendiceal variety, carcinoids must be considered malignant tumors and treated as such.—*J. Lorman, M.D.*

Johnstone, A. S. Symposium—diverticula of the alimentary tract. I. Diverticula of the oesophagus. *Brit. J. Radiol.*, Aug., 1949, *22*, 415–422.

Esophageal diverticula are due either to pulsion, traction, or a combination of both. Most are true diverticula, containing all the layers of the wall. Almost all are acquired.

Zenker's hypopharyngeal diverticulum usually contains no muscle layer but the author records one case in which the sac was capable of independent contraction. Once the sac forms, it is enlarged by both the downward thrust of the bolus of food and the upward movement of the pharynx.

Diverticula of the middle third are believed to be on the basis of traction. It is suggested that this traction frequently arises by stretching adhesions between the eosphagus and either the aorta or the left bronchus as the aorta unfolds in arteriosclerosis. These are usually less than 2 cm. in size. The importance of these diverticula depends on whether or not they retain barium for more than a few moments. They are to be differentiated from pouches which develop because of muscular incoordination in a "corkscrew esophagus."

Diverticula in the lower third are to be dif-

ferentiated from hiatus hernia. They are unusual and, contrary to general belief, are not frequently found associated with obstruction at the cardia.

Symptoms associated with esophageal diverticula are rare. Complications, as ulceration, abscess formation, perforation, bronchial fistula, mediastinitis or malignancy are also very rare.—*E. F. Lang, M.D.*

Fawcitt, Richard. Symposium—diverticula of the alimentary tract. III. The radiological aspects of diverticula of the stomach and small bowel. *Brit. J. Radiol.*, Aug., 1949, *22*, 427–436.

Gastric diverticula are: (1) congenital, when all the layers are intact; (2) acquired, when organic disease has caused the pouching, and all layers may be present but may be thinned or broken; and (3) false, due to herniation of layers through the muscularis, as a result of trauma. Pancreatic tissue may be found in gastric or intestinal diverticula down to the level of a Meckel's diverticulum.

The roentgenographic criteria are: (1) a mobile sac, with a broad or narrow neck; (2) a smooth regular shadow; (3) usually no tenderness; (4) rugae in the neck of the diverticulum; (5) the presence of a niche-like spot surrounded by a defect in the contrast shadow. These lesions at times require a tilting table for demonstration. The commonest location is in the cardia, but many occur in the pyloric region as well. Care should be used in differentiating ulcerations, both benign and malignant. Gastroscopy is an important aid in diagnosis.

Most duodenal diverticula are acquired and are usually on the concavity of the curve. They are rare in the bulb, and twice as common in the descending as in the horizontal segment.

Isolated diverticula of the jejunum are quite rare, and multiple diverticula are somewhat less uncommon. The incidence becomes less as the distance from the duodenojejunal junction increases. Most of these are acquired rather than congenital. Meckel's diverticulum is congenital in origin and was probably the first type recognized. They are demonstrated roentgenographically only very seldom.—*E. F. Lang, M.D.*

Edwards, Harold C. Symposium—diverticula of the alimentary tract. IV. Diverticula of the small intestine. *Brit. J. Radiol.*, Aug., 1949, *22*, 437–442.

The commonest type of congenital small intestinal diverticulum is Meckel's which occurs in 1.5 to 2 per cent of otherwise normal individuals. It only exceptionally causes trouble by (1) retaining its attachment to the abdominal wall and producing obstruction as a band, or permitting rotation of the entire small intestine; or (2) containing gastric or pancreatic epithelium, the secretions of the former of which produce a peptic ulcer with possible pain, bleeding or perforation. The pancreatic tissue is frequently a nodule in the fundus which may become intussuscepted.

The other congenital diverticula are quite rare. They are giant diverticula which are probably examples of reduplication, and there are traction diverticula apparently drawn out by masses of aberrant pancreatic tissue. Some diverticula are actual cysts, with a lumen separated from the rest of the alimentary tract.

There are two important types of acquired diverticula, The first is primary or hernial in origin and occurs as a result of increased pressure with protrusion of the mucosa and possibly the muscularis mucosae through the muscularis propria. The commonest site is perivaterian. The commonest symptom is flatulent dyspepsia; but rare symptoms are pressure on the common bile duct, or those associated with obstruction, inflammation, or ulceration. Frequently they are symptomless.

The second type of acquired diverticulum is that associated with scarring of the duodenal bulb incident to a chronic duodenal ulcer. Contraction of the scar results in bulging of intervening normal areas. These are never responsible for symptoms in themselves but merely indicate the presence of scar tissue due to duodenal ulcer.—*E. F. Lang, M.D.*

Grout, J. L. A. Symposium—diverticula of the alimentary tract. V. Diverticulosis and diverticulitis of the large intestine. *Brit. J. Radiol.*, Aug., 1949, *22*, 442–448.

Before the development of radiology, the incidence and importance of colonic diverticula were not realized.

Diverticula are found in about 9 per cent of consecutive barium enema examinations. They occur most commonly in the descending and sigmoid regions, and are rare in the cecum and the rectum.

Diverticulosis and diverticulitis are fairly easily differentiated roentgenologically, but the

prediverticular stage is difficult to distinguish. Spasticity of a segment of colon associated with serration or rippling of the bowel margins with notching at the apices of the haustra are considered suggestive, although the cautious usually require the presence also of at least one diverticulum to make a diagnosis of "prediverticulosis."

Carcinoma occurs in the same proportion of patients with diverticula as those without. At times the differential diagnosis is extremely difficult. In diverticulitis the mucosa presents a transversely puckered appearance, the margins of the lesion are poorly defined, and there are usually other diverticula in the colon. In carcinoma the mucosal pattern is destroyed and is patchy and irregular, the demarcation of the lesion is usually abrupt with frequently a "reentrant" angle, and there may be diverticula in the remainder of the colon also.—*E. F. Lang, M.D.*

Wells, Charles. Symposium—diverticula of the alimentary tract. VI. Diverticula of the colon. *Brit. J. Radiol.*, Aug., 1949, *22*, 449–458.

The reasons for the development of diverticula in the colon are not clear. The basic factor is increase in pressure which may be the pressure of peristalsis. Diverticula occur where the colonic wall is weak, and this weakening may be on the basis of a developmental abnormality, or local spesis, or both. When diverticula develop, they are permanent, and because of the nature of the colonic content and inevitable stasis in diverticula, when diverticulosis exists, diverticulitis always does also. Well developed diverticulitis may be treated medically with dietary supervision and lubrication, or surgically with resting of the involved segment by proximal colostomy.

Untreated diverticulitis progresses to fibrosis Chronic partial obstruction is the result with the ever present risk of acute obstruction if there is some precipitating factor such as an impacted fruit stone.

Common sequelae of diverticulitis are suppuration and gangrene. Acute perforation, with generalized peritonitis, localized abscess formation or fistula formation may result. Peritonitis or abscess is usually most satisfactorily treated with the addition of a proximal colostomy to the other measures.

Fecal fistulae develop from rupture of a pericolic abscess, and may communicate with the small intestine, the vagina, the skin, or the urinary bladder. The usual cause of vesicocolic fistula is diverticulitis, but other causes, as malignancy of the pelvic colon or even malignancy of the bladder, are also possible.—*E. F. Lang, M.D.*

Swenson, Orvar, Rheinlander, Harold F., and Diamond, Israel. Hirschsprung's diseases; a new concept of the etiology; operative results in 34 patients. *New England J. Med.*, Oct. 13, 1949, *241*, 551–556.

The authors present evidence that the primary lesion in congenital megacolon is malfunction of a constricted segment of rectosigmoid producing chronic partial colonic obstruction. Neuhauser has demonstrated by roentgenological examination in 40 patients a narrowed segment of rectosigmoid, distal to the dilated sigmoid, and considered pathognomonic of Hirschsprung's disease. The lesion may be difficult to demonstrate, and is easily missed if the area is flooded with barium. The rectosigmoid should be filled slowly under fluoroscopy in an oblique position.

The clinical features are those following chronic, low, partial colonic obstruction: severe constipation, visible peristalsis, and fecal impaction with an empty rectal ampulla. The picture is relieved by colostomy, but recurs when the colostomy is closed, Resection of the rectum and rectosigmoid, using a special technique which preserves the anal sphincter, resulted in 1 postoperative death in 34 patients, and in what appears to be complete cure in the remaining 33 patients. By the third postoperative month, the colon is normal in size, contour, and emptying capacity, and the patients do not need enemas or laxatives in the postoperative state.

Balloon studies of the colon in patients with Hirschsprung's disease show good peristaltic waves in the colon, but the waves fail to enter the narrow rectosigmoid region, the latter instead showing a constant level of increased tonus and failure of relaxation. Histological studies show the myenteric plexus present in the dilated colon, but absent in the narrowed rectosigmoid. The authors suggest that, at least in some cases, congenital megacolon is due to segmental absence or abnormal distribution of the myenteric plexus.—*H. P. Brean, M.D.*

Mayfield, L. H., and Waugh, J. M. Sigmoidovesical fistulas resulting from diverticulitis

of the sigmoid colon. *Ann. Surg.*, Aug., 1949, *130*, 186–199.

The authors present 32 cases of sigmoidal diverticulitis complicated by the occurrence of sigmoidovesical fistulae. Of this group 87.5 per cent were males with an average age of fifty-four years. The low incidence in women is attributed to the protection of the bladder by the female pelvic viscera. The symptoms include abdominal pain, constipation, diarrhea, frequency of urination and dysuria. Passage of feces in the urine is present in only about half of the patients. The most important symptom is pneumaturia.

Roentgenologic examination in addition to demonstrating the presence of the diverticula and the diverticulitis visualizes the fistulous tract in about 40 per cent. By cystoscopy evidence of diffuse cystitis is evident in all cases and in 50 per cent the fistulous opening can be seen.

The authors advocate resection of the involved segment of the colon with the use of a proximal colostomy six months prior to resection.—*T. D. Allison, M.D.*

Weaver, F. M., and Holland, R. H. Perforation of the colon following the use of enemas. *Surgery*, April, 1949, *25*, 613–616.

Three cases in which perforation of the colon after the use of enemas was fatal are reported. In each case the perforation occurred just proximal to an obstructing carcinoma. The tumor was in the sigmoid colon in 1 case and in the rectosigmoid colon in 2 cases. Each patient experienced sudden shock with pain in the lower part of the abdomen after administration of the enema. The authors recommend thorough examination of the rectum, colon and feces before any therapy in the form of enemas is instituted, especially in middle-aged and elderly patients. Perforation is attributed to the sudden forceful injection which initiates massive peristaltic movement. This may cause ejection of the enema with great force and velocity through a bowel the wall of which has been weakened by prolonged distention and possible malignant change.—*C. B. Holman, M.D.*

Nobile, Carlo. Sul quadro radiologico del volvolo del sigma. (On the roentgenologic picture of sigmoid volvulus.) *Ann. radiol. diag.*, 1949, *21*, 378–395.

This article reports 7 cases of surgically verified sigmoid volvulus with a discussion of the roentgen findings. While most cases are apparent with the flat film and the barium enema, atypical cases require additional films in upright and Trendelenburg positions as well as a film after evacuation of the barium enema. The importance of distinguishing this type of obstruction from that of carcinoma, which is also common in the rectosigmoid region, is apparent.

The characteristic roentgen signs are as follows:

1. On the flat film of the abdomen there is an enormously dilated loop usually lacking haustrations, occupying the left upper quadrant of the abdomen and having the configuration of an inverted "U." It may on occasion be in the midline or rarely in the right upper quadrant. At times the outlines of the loop are lost or altered by additional distended segments of bowel and then the barium enema is needed for diagnosis.

2. In the upright position there is usually an air-fluid level in each arm of the involved sigmoid loop. Other air-fluid levels indicate additional loops and require a barium enema to disclose the underlying volvulus. The additional loops may be due to adhesions, peritonitis, or mesenteric compression.

3. In the Trendelenburg position, the trapped air rushing down into the two arms of the distended loop may show a smooth twisted termination of one of them. The zone of torsion at the base of the loop is usually indistinctly opaque, but this may be lost when there are numerous other dilated loops which make the entire abdomen radiolucent.

4. The barium enema usually shows a conical, tortuous, smooth obstruction at the rectosigmoid level which may be permanent or temporary, and is usually eccentric with respect to the bowel lumen. Should the barium pass this defect it outlines a markedly dilated loop in which it may be retained despite attempts at evacuation. Following evacuation, spiral convergent mucosal folds in the area of the defect may be apparent. The author considers the defect with its convergent folds pathognomonic, but the diagnosis may be made without them if there are other presumptive signs as described above and if the clinical picture is corroborative.

By considering the underlying factors involved in volvulus, the variations in the roentgen findings are more readily understood.

Torsion of the pedicle of mesentery crushes

vessels and nerves producing an adynamic ileus of the involved loop. Proximal to this loop, the obstruction is in effect mechanical and may give rise to dilated loops of bowel with air-fluid levels.

The obstruction produced depends upon the length of the sigmoid loop, its mesentery, the distance between the fixed points of the sigmoid colon, and the added element of torsion about the long axis of the bowel. Thus, if this torsion is short and marked, the obstruction will be clear cut, conical and permanent, and will show corresponding convergent, spiral mucosal folds. If the torsion extends over a long segment of bowel, there may be little if any defect and little if any mucosal alteration. In addition, the mucosa is normally subject to wide variations, and mucosal folds may be largely absent despite the presence or absence of an obstruction. When the mesentery is redundant, the defect may escape detection by being superimposed on the shadow of the barium-filled ampulla. This is usually overcome by evacuating the rectum or by examination in various oblique positions to separate the two structures.—*C. Colangelo, M.D.*

Garcia, Manoel F. Vesicula dupla; relato de um caso. (Double gallbladder; report of case.) *Rev. brasil. de gastroenterol.*, Nov.–Dec., 1949, *1*, 603–609.

Double gallbladder in man is relatively rare, occurring only in the approximate ratio of 1 in 4,000. It is more frequent in other mammals, reaching a frequency of 12 per cent in cats.

Double gallbladder must be differentiated from bilobate or bifid gallbladder where a membranous septum in one gallbladder produces two cavities and where only one cystic duct exists.

So far 51 cases of double gallbladder have been described in the medical literature; the majority of the cases were diagnosed by means of cholecystography. The dye filling of double gallbladder varied widely, depending largely on pathologic complications, extrinsic pressure and technical factors. In the few cases complicated by cholelithiasis, calculi were observed either in one or in both gallbladders. When there is suspicion of this abnormality, double dye dosage and posteroanterior, lateral, oblique and erect views are recommended. No pathognomonic clinical symptoms exist.

A case of double gallbladder is described and illustrated by the author, observed in a fifty-nine year old woman who, over a period of more than twenty years, had been suffering from pain in the right hypochondrium, attacks of bilious vomiting, hyperchlorhydria, nausea, eructation and flatulence. Two negative shadows, apparently biliary calculi, could be demonstrated in one of the two well delineated gallbladders. In view of the patient's refusal to accede to operation, the roentgen diagnosis could not be confirmed surgically or otherwise. —*E. A. Schmidt, M.D.*

Neibling, H. A., Dockerty, Malcom B., and Waugh, J. M. Carcinoma of the extrahepatic bile ducts. *Surg., Gynec. & Obst.*, Oct., 1949, *89*, 429–438.

Carcinoma of the extrahepatic bile ducts was found in about 0.5 per cent of all cases in which operations were performed on the biliary tract at the Mayo Clinic in a ten year period. In the authors' series of 90 cases it occurred 1.14 times more frequently among males than among females. The average age of the patients was about fifty to sixty years.

Jaundice was the most common complaint of 87 per cent of patients in the series prior to operation. Pain occurred in 61 per cent at some time during the course of the disease. Loss of weight was the earliest sign. Fever and chills were rare.

The concentration of direct reacting serum bilirubin averaged about 25 mg. per 100 cc. Acholic stools were noted in 91 per cent of the cases of jaundice. Aspiration of duodenal contents showed a decrease or absence of bile in the presence of jaundice.

In this series of 90 cases, 26 per cent of tumors were located in the hepatic ducts, 35 per cent at the juncture of the common, cystic and hepatic ducts, 32 per cent in the common duct, and 3 per cent in the cystic duct. Four per cent of the tumors were diffuse and no definite point of origin along the duct could be determined.

Jaundice may be due to physiologic as well as anatomic obstruction of the duct. This physiologic obstruction may be due to inhibition of nerve impulses.

Tumors of this series were all adenocarcinomas, many of which were productive of abundant amounts of mucus.

The disease was rapidly fatal and was usually far advanced in its course when operation was performed. Metastasis or extension occurred early in the disease. Even in a small

group of cases operated on prior to development of jaundice, metastasis was evident in 75 per cent. The average period of survival after operation was only about three or four months and after onset of jaundice it was only about five months.—*Mary Frances Vastine, M.D.*

GYNECOLOGY AND OBSTETRICS

Reid, F. The radiological localisation of the placental site. II. The radiological diagnosis of placenta praevia. *Brit. J. Radiol.*, Nov., 1949, *22*, 643–665.

Placenta previa has been demonstrated by amniography, cystography, tomography, and by films made without contrast media. The author has enlarged the latter method into an accurate system for demonstration of placenta previa. This system is based on the following assumptions: (1) in vertex presentations the fetal head is symmetrical in relation to the pelvic brim with the mother standing; (2) the lower uterine segment extends to the level of the pelvic brim in the last two or three months of pregnancy; (3) in low implantation the head is displaced either from the midline or from the anterior or posterior margins of the inlet.

Anteroposterior and lateral films are made with the mother standing. If this is not possible, the head of the table should be elevated at least 50 or 60 degrees. If it is necessary to obtain the smallest distance possible between the head and the promontory of the sacrum, an additional lateral film is made with the patient supine. Aberrations due to distention of the bladder or bowel are carefully excluded. Knowledge of any pelvic tumor is also important.

In a normal implantation and in views made with the presenting part as close as possible to the sacral promontory or to the symphysis pubis, the distance between the presenting part and these landmarks is usually not more than 1.2 to 1.5 cm. In practice, low implantation is rarely found unless the distance is more than 2 cm. The closer the pregnancy to term, the more significant does the figure of 2 cm. become, particularly if there is lateral displacement. If the distance is greater than 2 cm., a low normal implantation cannot be excluded, but the greater the displacement, the more likely is placenta previa. Lateral deviation and duration of gestation are also factors.

The author found positive roentgenological evidence in 47 of 50 cases in which there was clinical evidence of placenta previa. In the 3 errors, the erect position during roentgenography was not used.—*E. F. Lang, M.D.*

Hertig, Arthur T., and Sommers, Sheldon C. Genesis of endometrial carcinoma. I. Study of prior biopsies. *Cancer*, Nov., 1949, *2*, 946–956.

Five hundred cases of endometrial carcinoma were reviewed and 32 cases, which had previous endometrial biopsies one year or more previously, were intensively studied.

Nineteen cases showed adenomatous hyperplasia. This was most common three to five years before the cancer occurred. Endometrial polyps and cystic hyperplasia and anaplasia were seen somewhat less often. Twelve cases were negative and showed no hyperplasia of any sort.

Radiation therapy had been used previously in 20 cases. The unusual incidence of carcinosarcoma (3) suggested some correlation. The exact amount of radiation to the individual cases was not mentioned—only average figures given.

Statistical analysis of 389 cases in detail demonstrated frequent association with obesity, diabetes mellitus, and nulliparity. Evidence suggesting pituitary-ovarian dysfunction is presented.—*R. C. Datzman, M.D.*

Sommers, Sheldon C., Hertig, Arthur T., and Bengloff, Harold. Genesis of endometrial carcinoma. II. Cases 19 to 35 years old. *Cancer*, Nov., 1949, *2*, 957–963.

Sixteen cases of endometrial carcinoma in the age group nineteen to thirty-five are studied. Menorrhagia, sterility, amenorrhea, and obesity were frequently seen. The earlier endometrial biopsies done in 5 of the cases showed polyps, cystic and adenomatous hyperplasia, anaplasia, or cacinoma in situ.

Since 9 of 11 cases showed some type of ovarian cortical hyperplasia or fibrosis, it was thought that hormonal imbalances involving the anterior pituitary, adrenal cortex, and ovary played some part in the genesis of endometrial carcinoma.—*R. C. Datzman, M.D.*

Hertig, Arthur T., Sommers, Sheldon, C., and Bengloff, Harold. Genesis of endometrial carcinoma. III. Carcinoma in situ. *Cancer*, Nov., 1949, *2*, 964–971.

Sixty-four cases of endometrial carcinoma

in situ were analyzed. The age range was from twenty-five to sixty-eight years. Thirty-three per cent were nulliparous and 54 per cent were obese. It was felt that in time these cases would be succeeded by invasive carcinoma. These carcinomas in situ have a characteristic pale, eosinophilic glandular pattern. Practically all the patients had irregular bleeding.—*R. C. Datzman, M.D.*

GENITOURINARY SYSTEM

Braibanti, T. Considerazioni su un caso di dispasia cistica del rene. (A case of cystic dysplasia of the kidney.) *Ann. radiol. diag.*, 1949, *21*, 412–420.

The author describes a case of unilateral polycystic kidney in which there was a cyst-like dilatation of one superior calyx. Preoperatively, the roentgen appearance of an enlarged kidney with a cavity as demonstrated by pyelography suggested tuberculosis. The other kidney was completely normal on pyelography. At surgery, the polycystic appearance of the involved kidney was typical so that resection was limited to the superior pole. Microscopic examination of the dilated calyx showed a flat type of epithelium in one or two layers which in some areas formed papillary projections having vessels in the stalks. There follows a discussion of the etiology of various renal dysplasias such as polycystic kidney, cyst of the kidney pelvis, and congenital caliectasia. Polycystic kidney is believed to result from imperfect fusion of the secreting and excreting portions of the kidney tubules. The other similar dysplasias are based upon related structural embryological alterations which often makes differentiation by roentgenological means difficult.—*C. Colangelo, M.D.*

Leighton, Robert S. Nephrography; experimental and clinical observations. *Radiology*, Oct., 1949, *53*, 540–547.

This is mainly an experimental study of artificially produced lesions in the kidneys of dogs by nephrography. The study suggests that nephorgraphy may be of value in humans. Clinically proved cases of lesions demonstrated by nephrography are not presented.—*J. M. Dell, Jr., M.D.*

Bondani, Luigi. Rilievi sull'impiego di un nuovo mezzo di contrasto (Bismjol) per la pielografia retrograde. (Results with use of a new contrast medium (Bismjol) in retrograde pyelography.) *Ann. radiol. diag.*, 1949, *21*, 335–345.

After reviewing the development and use of various contrast media in retrograde pyelography, the author illustrates with numerous film reproductions the superior radiopacity of bismjol. He describes in detail his technique.

Bismjol contains besides sodium iodide, sodium bismuth iodide and therefore is more radiopaque. Also it is less expensive than comparable products now in use. Testing it in a series of 21 cases no local or generalized toxic symptoms were observed in any of these patients.

Bismjol contains 0.12 gm. of sodium bismuthite and 0.24 gm. of sodium iodide dissolved in 2 cc. of ethylene glycol.—*P. E. Russo, M.D.*

Harrison, F. G., Warres, H. L., and Fust, J. A. Primary carcinoma of the ureter. *Ann. Surg.*, Nov., 1949, *130*, 902–912.

Seven cases of primary carcinoma of the ureter are presented, and the literature reviewed. The cases reported conform to the pattern of this neoplasm as recorded in the previous literature. Hematuria occurs in about 75 per cent of all cases; it is usually profuse, intermittent, and not accompanied by pain. Dull dragging pain in the flank or abdomen is common (60 per cent of cases), and originates from a hydronephrotic kidney which results from neoplastic ureteral obstruction. The tumor itself is rarely palpable, although it may invade the periureteral tissue and form a mass of considerable size. Males are affected twice as frequently as females, and the fifth and sixth decades of life are the commonest time of occurrence.

The diagnosis is suggested by a non-functioning kidney by intravenous urogram and an obstruction or filling defect of the ureter on retrograde pyelo-ureterography. Often the tumor can be observed by cystoscope as it protrudes through the ureteral orifice (the lower one-third of the ureter is the most common site of these tumors).

All tumors of the ureteral mucosa should be regarded as potentially malignant. The treatment of choice, then, is extraperitoneal nephroureterectomy with removal of a cuff of bladder. Deep roentgen therapy has added little to the cure rate. The prognosis is poor, most patients dying within two years of operation, with metastases to the retroperitoneal lymph nodes, liver, bones, bladder, or lungs.

It is emphasized that a non-functioning kid-

ney on the intravenous urogram should prompt retrograde studies of the ureters to rule out an ureteral carcinoma.—*Harold Fulton, M.D.*

Dodge, Mark, Schmidt, Herbert W., and McDonald, John R. Use of polythene and polyvinyl tubing in ureterostomy, nephrostomy and cystostomy. *Proc. Staff Meet., Mayo Clin.*, Aug. 18, 1948, *23*, 385–390.

The use of drainage tubes made of rubber following operations on the kidneys, ureters or bladder has been beset with difficulties because of the tendency for deposition of calcium along the inner and outer aspects of these rubber tubes. This has necessitated frequent changing of the tube, has produced occasional complications due to obstruction of the tube and has carried a hazard of dislodgment of some of this extraneous calcium into the urinary tract where it acts as a foreign body.

In order to overcome these difficulties plastic materials in the form of tubing were tried. Polyvinyl tubes were found to be the most satisfactory. They were flexible and easily sterilized and maintained their integrity for many weeks in drainage wounds. Their great superiority consisted of the fact that no deposition of calcium occurred either within or without the plastic tubes in the 7 patients in whom the plastic tubes were tried.

This information should be of distinct advantage to urological surgeons and possibly other uses for the plastic tubing will be found in other branches of surgery.—*R. P. Barden, M.D.*

NERVOUS SYSTEM

Craig, W. McK., and Horrax, Gilbert. The occurrence of hemangioblastomas (two cerebellar and one spinal) in three members of a family. *J. Neurosurg.*, Nov., 1949, *6*, 518–529.

The familial character of hemangiomatous cysts and tumors of the central nervous system has been stressed by numerous writers, this characteristic perhaps being true particularly of patients having associated angiomatosis of the retina as well as cysts of other organs such as the kidney, pancreas, liver, and so forth. The 3 patients reported here present several interesting features. In the first place the hemangiomatous cysts of the cerebellum in the mother and 1 daughter have been verified histopathologically. The mother likewise had a probable angioma of the retina (and kidney?). One other daughter has angiomatous or hemangiomatous tumors, identified by inspection, involving both the cervical and lumbar portions of her spinal cord.

Certain marked differences in the symptomatology and clinical findings are reported in detail. In one normal ventricles were disclosed after intracranial symptoms had been present for a year, while in the other there was great ventricular dilatation only two to three months after such symptoms had appeared.

So far as treatment is concerned, both patients with cerebellar tumors have apparently been cured by the complete removal of their growths which in both instances, however, was accomplished only after extreme operative difficulties. Operative removal of the spinal lesion or lesions was obviously impossible, but arrest of the condition by deep roentgen therapy sometimes may be hoped for. In similar lesions of less wide extent so treated the authors have seen a return to perfectly normal cord function which is still present 10 years following laminectomy and roentgen therapy.—*K. K. Latteier, M.D.*

Epstein, Joseph A., Beller, Aaron J., and Cohen, Ira. Arterial anomalies of the spinal cord. *J. Neurosurg.*, Jan., 1949, *6*, 45–56.

Vascular anomalies of the central nervous system include both arterial and venous malformations. Although found most frequently in the brain, they have also been encountered in the spinal cord and retina. While the venous and arteriovenous abnormalities have received much attention, those of an arterial nature have rarely been described.

In studying the reports of operations for spinal cord neoplasm, the authors found 6 cases which could be classified as arterial anomalies. Five cases were also found in the literature after eliminating those of a venous or arteriovenous character. Of the entire group, 9 were men and 2 were women. The youngest was thirty-five, the oldest sixty-two and the average age was fifty-four. The symptoms were progressive in nature without remission in 7 cases and were intermittent with gradually developing signs of progression in 4. In the first group, the duration of the illness was comparatively short, varying from periods of one to eight months to a maximum of two years. In the second group, the duration was from three to eight years. In 1 case, progressive symptoms of one

month's duration were climaxed by a sudden hemorrhage into the subarachnoid space with signs of an acute transverse myelopathy. Noteworthy was the absence of cutaneous nevi. This is in contrast with the numerous reports of skin hemangiomas in venous or arteriovenous anomaly of the spinal cord.

The neurological examination was characterized by sensory levels that shifted during the same and on subsequent days. Findings of progressive cord damage with final evidence of a complete transverse myelopathy were the presenting features or followed in the wake of recurrent attacks. The findings resulted in numerous diagnoses such as tabes, amyotrophic lateral sclerosis, combined sclerosis and most frequently, neoplasm.

Myelography showed no evidence of block in 2 cases, a partial block in 5 and a complete block in 1. In the 2 cases of the authors' series in which pantopaque was used through both the cisternal and endolumbar routes, fluoroscopy disclosed interruption in the column of oil at the upper level of the lesions with a subsequent dispersal into small rivulets and droplets whose outlines formed a pattern defining the course of tortuous, convoluted vessels, at the same time vaguely suggesting arachnoid adhesions. Roentgenograms showed with clarity the defects suggested during fluoroscopy. These findings are the only means by which a preoperative diagnosis may be ventured with assurance.—*K. K. Latteier, M.D.*

Hannan, John R., Hughes, C. Robert, and Mulvey, Bert E. Spinal cord tumors. *Radiology*, Nov., 1949, *53*, 711–719.

This article deals with a review of 71 primary tumors arising within the spinal canal and beneath the dura in 68 patients and the authors state that since 60 to 85 per cent of spinal cord tumors are benign and potentially curable, it is of the utmost importance to establish the diagnosis before irreversible pressure changes have occurred in the cord.

The pathologic distribution of cord tumors is discussed in some detail.

The authors found that the mean average age in their patients was forty years, with 41 of 68 patients females. The mean average time from onset of symptoms to the diagnosis of cord tumor was twenty-four months. If one symptom can be called characteristic of cord tumors, it is pain, described as burning or lancinating. The amount of neurological manifestation is dependent upon the position of the tumor in the cord. Many patients had received various forms of physical therapy and surgical procedures including spine fusion and nephropexy before the accurate diagnosis had been made. The importance of a spinal fluid examination in the diagnosis of cord tumor cannot be overemphasized. Supporting a positive diagnosis of cord tumor would be a partial or complete subarachonid block. An elevated protein value above 40 mg. per cent in the absence of degenerative or inflammatory disease of the cord or brain supports spinal block evidence.

The roentgenographic manifestations include erosions and infiltrations of the spinal canal with alteration in the pedicles and detectable calcification in the tumors, both of which are seen on plain film study when present. The importance of myelography is discussed with emphasis on withholding introduction of opaque medium into the spinal canal until all other methods of diagnosis have been attempted. Characteristic defects seen in myelography are shown. The authors accurately localized cord tumor, by this method, in 94.6 per cent of the cases in which myelography was attempted.

The article is well illustrated and presents one pathological classification table.—*J. H. Gilmore, M.D.*

Dobrina, D. Mezzi d'indagine radiologica per la diagnosi della sciatica discale pneumorachide e pantopaque. (Air and pantopaque myelograms in the diagnosis of sciatica from disk herniation.) *Ann radiol. diag.*, 1949, *21*, 347–357.

Sciatic syndrome from disc herniation usually requires myelograms if roentgen evidence of disease is desired since the plain films are frequently normal. Occasionally a lumbar interspace may be narrowed or there may be malformations or arthritic changes.

The author describes the technique for myelography with air under pressure, pantopaque, oxygen, and lipiodol. His preference is air myelography since he feels it is as informative as pantopaque myelography yet requires no extraction of opaque medium. He admits that pantopaque studies are more readily interpreted.—*C. Colangelo, M.D.*

SKELETAL SYSTEM

Foged, Jens. Temporomandibular arthrosis. *Lancet*, Dec. 31, 1949, *2*, 1209–1211.

This surgical lesion, involving one of the most important joints in the body is due to a degenerative, non-infectious condition and is usually identified by one of its more common symptoms, namely temporomandibular snapping or cracking. The lesion is found mostly in persons aged twenty to thirty years, more often in women. In addition to cracking, pain, reduction in mobility and difficulty in mastication are the more prominent symptoms. Roentgen examination often reveals: deformities of the capitulum and articular tubercle, irregularities in the contours of the articular surfaces, narrowing of the point space, and the presence of a sclerotic subchondral marginal zone. Reduced mobility of the capitulum during maximal opening of the mouth, together with upward and backward displacement is also often noted.

In many cases, however, the roentgen findings were normal.

The pathologic changes found at operation were: (1) altered mobility, either abnormal looseness, or, more often, too firm fixation of the capitulum by fibrous adhesions; (2) occasional obliteration of the lower joint cavity; (3) macroscopic and microscopic degeneration of the articular cartilage.

Treatment in most instances consists of restoring the bite to normal. In obstinate cases where surgery is indicated, the meniscus is extirpated and adhesions severed.—*C. N. Borman, M.D.*

Evans, E. Mervyn. Pronation injuries of the forearm. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 578–588.

With a fall forward on to the hand, the forearm is pronated and the hand is palm downwards. If the body is twisting outwards at the moment of impact, a strong pronation force is transmitted through the humerus to the forearm. On theoretical grounds, one would expect forced pronation to cause one of three injuries: (1) fracture of the ulna in its middle third with backward angulation and anterior dislocation of the head of the radius—the anterior Monteggia fracture with occasional damage to the head or the epiphysis of the radius at the same time; (2) fracture of the ulna as in the first instance with a high fracture of the radius; (3) anterior dislocation of the head of the radius without fracture of the ulna.

This paper is devoted mainly to consideration of the anterior Monteggia fracture, the treatment of which has long been considered difficult. The author in an attempt to determine the mechanism of this fracture carried out experiments on 18 dissecting room specimens. He concludes that anterior dislocation of the head of the radius with or without fracture of the ulna is a forced pronation injury. He believes that full supination is essential for reduction and immobilization in full supination is the surest safeguard against recurrence of the deformity.—*R. S. Bromer, M.D.*

Watson-Jones, Reginald. Léri's pleonosteosis, carpal tunnel compression of the median nerves and Morton's metatarsalgia. *J. Bone & Joint Surgery*, Nov., 1949, *31B*, 560–571.

The author states there is no account in English literature of the dystrophy described by Léri as pleonosteosis (Gr. pleon-superabundant), which is characterized by broadening and deformity of the thumbs, flexion contracture of the fingers, thickening and stiffness of the toes, limited movement of other joints, shortness of stature and a mongoloid facies. Four patients with typical contractures of the fingers and toes are described in this paper. In one there was bilateral compression of the median nerves in the carpal tunnels and bilateral Morton's metatarsalgia with plantar digital neuromata. These complications of pleonosteosis have not been described before and they may be significant in the pathology of the disease.

The review of the literature suggests that the deformities are due to capsular contracture rather than deformity of bone. In one patient there was striking evidence of fibrocartilaginous thickening of the anterior carpal ligaments. It suggests that the primary pathological change in pleonosteosis may be in the joint capsule rather than in the epiphyses. The patient with thickening of the anterior carpal ligaments had bilateral median palsy from carpal tunnel compression.

Acute carpal compression of the median nerve may be due not only to dislocation of the semilunar bone but to hemorrhage in the palm. Late compression may occur twenty to fifty years after injury. Late compression without bony abnormality has been attributed to occupational stress, but the author suggests that pathological thickening of the anterior carpal ligament may be the cause.

The patient with pleonosteosis and bilateral median palsy had also bilateral Morton's metatarsalgia with large digital neuromas. Plantar

digital neuritis has already been shown to be an ischemic nerve lesion preceded by degenerative changes in the digital artery. The significance of the fibrous tunnel through which the artery passes to reach the digital cleft was pointed out by Nissen (1948). In the author's case it seems possible that the ischemic nerve lesions in the feet were due to compression of the digital arteries by abnormal plantar ligaments, comparable to the proved compression of the median nerve by abnormal carpal liagments.

In Léri's original report he was impressed by the bone changes, particularly the large epiphyses and thick metaphyses of the phalanges and metacarpals. He thought that excessive epiphyseal development was the characteristic feature and that this accounted for the postural abnormality and limitation of joint movement.—*R. S. Bromer, M.D.*

RUSHFORTH, A. F. A congenital abnormality of the trapezium and first metacarpal bone. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 543–546.

Congenital abnormalities of the trapezium are uncommon. In the case reported the roentgenograms showed that the abnormality was almost symmetrical and consisted of enlargement of the base of the metacarpal and gross alteration in shape of the trapezium, which was longer than normal and presented an acute angle on the radial aspect. Each trapezio-metacarpal joint was deformed. There was a separate ossicle in each hand, on the right at the outer angle of the trapezium forming part of the joint surface, and on the left on the palmar surface, seen more clearly in the lateral roentgenogram in the position of the tuberosity. The trapezio-metacarpal joints were obviously arthritic with narrowed joint spaces, but were also distorted as if they had migrated proximally. The condition may be related to abnormal ossification of the trapezium. It is quite distinct from osteoarthritis of the trapezio-metacarpal joints.—*R. S. Bromer, M.D.*

LASSERRE, C., PAUZAT, D., and DERENNES, R. Osteoarthritis of the trapezio-metacarpal joint. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 534–536.

The trapezio-metacarpal joint is the most important site for hypertrophic arthritis in the hand. Anatomically, the trapezium is an intermediate bone placed in a particularly vulnerable position between the hammer of the first metacarpal and the anvil of the scaphoid.

Roentgenologically, the diagnosis of trapezio-metacarpal arthritis was difficult, the authors state, until Robert (1936) demonstrated the value of placing the hand in forced pronation. The standard dorsopalmar film, they regard as of no practical use at all, except in advanced cases when it merely confirms the presence of a grave lesion in the joint.

Very often symptoms first arise during manual work. Roentgen changes in the joint may include: (a) narrowing of the joint space; (b) subchondral condensation of bone; (c) lateral subluxation; (d) osteophyte formation on the lateral borders of the metacarpal and trapezium; (e) deformation of the medial and distal angle of the trapezium.

In gross trapezio-metacarpal arthritis the diagnosis can be made clinically and the roentgenograms show clear details of the lesion. In an extreme case, dislocation can be so marked that the base of the metacarpal is opposite the trapezio-metacarpal joint. The joint space is not visible, but fluoroscopic observation may show that it is partly preserved. In all cases the greatest deformity and largest osteophytes are at the distal and medial angle of the trapezium. This is a point of first importance according to the authors.

In regard to treatment, they recommend that the patient at the least suspicion of trouble should wear an apparatus to hold the joint in abduction.—*R. S. Bromer, M.D.*

RUSSELL, T. B. Inter-carpal dislocations and fracture-dislocations. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 524–531.

Fifty-nine patients with various intercarpal dislocations are reviewed in this paper. In the series trans-scapho-perilunar fracture-dislocation was the commonest injury. Other types of injury were dislocation of the lunate; forward dislocation of lunate and half of scaphoid; perilunar dislocation of the carpus; subluxation, recurrent subluxation and dislocation of the scaphoid; anterior dislocation of the trapezium; posterior dislocation of trapezoid; anterior dislocation of lunate and perilunar transstyloid fracture-dislocation; dislocation of the capitate and trapezoid.

Early cases of trans-scapho-perilunar fracture-dislocation can be reduced by closed manipulation but in late cases operative reduction is usually advisable. When the injury is more than three months old, arthrodesis of the wrist joint is indicated. When this injury was complicated by avascular necrosis of the proximal scaphoid

fragment the results in a small series treated by early excision were approximately equal to those treated by continued immobilization. The results of grafting the scaphoid were poor. Dislocations of the lunate seen within ten days of the injury could usually be reduced with good results. No such case developed Kienböck's disease within the period of review. In late cases excision gave satisfactory results. Forward dislocation of the lunate with half of the scaphoid gave good results when manual reduction succeeded, but the results of excision of fragments were less satisfactory.

Subluxation of the scaphoid is disclosed in anteroposterior roentgenograms by a typical gap between it and the lunate bone. The subluxation may become recurrent.—*R. S. Bromer, M.D.*

Therkelsen, F., and Andersen, K. Lunatomalacia. *Acta. chir. Scandinav.*, March, 1949, *97*, 503–526.

Numerous theories have been advanced regarding the pathogenesis of Kienböck's disease. Among these may be mentioned contusion or distortion (Kienböck), multiple embolic processes (Axhausen), fracture resulting from a single trauma (Hirsch,) constitutional predisposition, streptococci, and vitamin and hormone deficiencies. At present there is a growing tendency to regard the disease as of traumatic origin, mainly because the semilunar is particularly exposed to pressure in the direction of the long axis of the arm, and occurs most commonly in manual workers.

In an attempt to further evaluate the etiologic factors giving rise to this condition, the authors have studied 109 cases of lunatomalacia occurring in the ten year period, 1934 to 1943. As in other reports, most of the cases occurred in manual workers, and over two-thirds of the cases were found in the right wrist. However, there was a history of unquestionable single trauma in only 38 per cent of these.

Adopting the terminology of Hultén and Persson, the authors have subdivided up their material into minus, zero or plus variants, depending upon whether the radial joint is more distal to, on the same level, or more proximal to, the ulnar joint surface. Forty-two per cent of minus variants were present in the material studied, and this constitutes a rather marked increase over the normal material, where approximately 9.4 per cent fall into this category. This finding suggests the importance of repeated trauma transmitted to the semilunar bone from the distal portion of the radius.

The most frequent finding on the roentgenograms was rather marked flattening of almost the entire bone. Other structural changes noted varied from thin condensed lines resembling the sequelae of compression fractures, through marked changes, with major and minor areas of translucency, and others of density, as if the bone had been broken into numerous fragments. Among correlative changes noted in the wrist, osteoarthritis was the most frequent finding. In a few instances there was more or less marked subluxation of the carpal scaphoid, and in several other instances increased density in the adjoining bones, especially the scaphoid, was noted. In the light of their investigations, the authors are of the opinion that the interpretation of malacia which ascribes its onset and development mainly to repeated trauma, is most likely the correct one.

From the follow-up study of 92 cases, it was concluded that excision of the semilunar is the form of treatment which is followed by the poorest results, and that immobilization in plaster of paris for more than two months does not improve the functional results. Also of importance to the roentgenologist is the fact that the roentgenologic changes following treatment did not always correlate with the functional result. For example, several of the cases that showed roentgenologic healing showed poor functional results, while several of the cases that appeared to be roentgenologically worse in the follow-up had ideal functional restoration of movement. The earliest complete roentgenologic healing occurred in two years.—*E. C. Lasser, M.D.*

Cave, Edwin F. Fractures of the long bones; editorial. *Surg., Gynec. & Obst.*, Nov., 1949. *89*, 643–644.

The healing process of a fracture begins as soon as the bone is broken and any delay in treatment postpones healing. Therefore, the broken bone should be realigned as soon as possible. This is particularly true if open reduction is to be done. The hematoma about the fracture site serves a very definite function and the less it is disturbed the better. The earlier the fracture is manipulated or placed in traction, the easier it is to reduce, and, once open reduction is deemed necessary, the only excuse for delay is an unfavorable condition of the local tissues or of the patient.

The vast majority of long bone fractures will heal if given the opportunity, and can, as in the

past, be effectively treated by manipulation and splinting, or traction. However, without question, certain fractures must be openly reduced and secured.

Broadly speaking, the following fractures should be treated by operation: (1) joint fractures in which there is gross misalignment of articular surfaces; (2) shaft fractures near a joint, where traction or manipulation will not realign the fragments satisfactorily and prevent ultimate deformity of the joint, particularly a weight-bearing joint; (3) fractures with gross interposition of soft tissues; (4) fractures with a large interposed third fragment, holding the main fragments apart; (5) fractures with shortening which cannot be corrected by traction; (6) fractures of the femoral neck.—*Mary Frances Vastine, M.D.*

Fairbank, H. A. Thomas. Achondroplasia. Synonyms—chondrodystrophia foetalis, micromelia. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 600–607.

Achondroplasia is a congenital condition resulting from interference with endochondral ossification and is characterized by dwarfism of the short limb type, associated with a large head and in many cases, so-called "trident hands." It is the commonest type of dwarfism and perhaps the most ancient.

As in previous selections from the Atlas of General Affections of the Skeleton, Fairbank gives in detail the hereditary and familial influences, the age incidence, the etiology, clinical features, roentgenographic appearances, pathology and diagnosis. In the roentgenogram the long bones are short, strong and rather dense. The femora and humeri may be less than two-thirds of the normal length. The shafts may be thickened but usually the increase in diameter is more apparent than real and is due to reduction in length. Splaying of the ends of the shaft is more abrupt and obvious than in normal bones and the terminal surface is irregular. The medullary canal is reduced in size and may be obliterated by cancellous bone. In some of the major long bones, notably in the region of the knee joint, the end of the shaft is notched centrally to form a V-shaped surface. The clavicles and fibulae are much less affected than other long bones. The fibular head lies higher than usual and occasionally it may even participate in the formation of the knee joint. A striking feature is the position of the epiphyseal center close to the end of the shaft and tucked into the apex of the V-shaped notch of the metaphysis when this is present. The skull is large and the sella turcica may be small. The characteristic feature is premature fusion of the pre-sphenoid, post-sphenoid and basi-occipital, to form an os tri-basilare which is abnormally short. The vertebral bodies may be somewhat reduced in depth but the total reduction in length of the spine is much less marked than that of the limbs. Even when fusion of the epiphyses is delayed, adults are always far below the normal in height.

In the differential diagnosis, the Morquio-Brailsford type of chondro-osteo-dystrophy and gargoylism must be differentiated. In cretinism the characteristic features are not present at birth as in achondroplasia. The only condition likely to simulate achondroplasia at birth is osteogenesis imperfecta. In a severe prenatal case of this condition, the subject whether alive or dead at birth may display marked shortening of the limbs, as compared with the trunk, but roentgenographic examination at once settles any doubt of the diagnosis. Short limbs at birth may also be seen in dysplasia epiphysialis punctata, but this is an exceedingly rare condition with unique roentgenographic features.

Excellent roentgenograms of 5 cases are reproduced.—*R. S. Bromer, M.D.*

Fairbank, H. A. Thomas. Cranio-cleido-dysostosis. *J. Bone & Joint Surg.*, Nov., 1949, *31B*, 608–617.

Cranio-cleido-dysostosis is characterized by deficient formation of the clavicles with delayed and imperfect ossification of the cranium, associated in many cases with other anatomical errors. For long it was thought that the changes were confined to bones that normally ossify in membrane but, in fact, bones performed in cartilage are often affected.

In the article are discussions of hereditary and familial influences, sex and age incidence, etiology, distribution of the abnormalities, clinical signs, roentgenographic appearances, complications, pathology and diagnosis. Roentgen examination of the membranous calvarium shows various degrees of imperfect ossification. The base is normally ossified. The anterior fontanelle is large and may never close. A fontanelle may be present posteriorly in both mastoid regions and also in the sphenoid. Wormian bones are seen in the occipital and posterior parietal regions. In extreme case, there may be no ossification whatever in most of the vault. The maxillae are hypoplastic but the mandible

is of normal dimensions. Fusion at the mandibular symphysis may be delayed or even fail to occur. In some cases ossification of the skull is normal.

The commonest defect as reported by Stocks and Barrington was absence of the outer end of the clavicle, the sternal end being present. The next commonest finding was the presence of two separate fragments for each clavicle. The inner was the larger of the two and the outer in some instances did not reach the acromion. The least common defect was absence of the sternal end with the acromial end present. Complete absence of the clavicles was uncommon.

In Fairbank's cases he noted in 10 patients, varying from three to eighteen years of age, deficient ossification of the pubis, the deficiency being bilateral in all cases. Ossification of the pubis is delayed but it occurs eventually though often incompletely. The inferior ramus of the pubis shares in the delayed and defective ossification.

In the author's series of 11 cases, there was coxa vara in 5, bilateral in 3, unilateral in 2. In the spine, failure of the neural arches is common. In the hands and feet, various abnormalities have been found, the most constant and curious being the presence of epiphyses at both ends of the metacarpals and metatarsals, particularly of the second and fifth, and an abnormally long second metacarpal. The epiphysis which occurs at the base of the second metacarpal is strikingly large.

The ribs may slope downwards to a greater degree than usual. The sternum may be of peculiar shape and failure of the manubrium to ossify has been reported.

Complications mentioned are pressure on the brachial plexus, relieved by removal of the outer fragment of the clavicle. An accompanying calcification in the skin and soft tissues has also been reported. Syringomyelia has been mentioned as a rare complication.

The diagnosis should present no difficulty. In a young patient with pseudarthrosis of a clavicle, with thickening of the fragments, and without obvious deficiency in the skull, roentgenographic examination of the pelvis might remove any doubts as to the case being due to an error in development and not to trauma.—*R. S. Bromer, M.D.*

Fitts, William T., Jr., Roberts, Brooke, Spoont, Stanley I., and Ritter, Vern W. The effect of intramedullary nailing on the healing of fractures; an experimental study. *Surg., Gynec. & Obst.*, Nov., 1949, *89*, 609–615.

Intramedullary nailing was introduced by Kuentscher of Germany in 1940. It seems to be a safe method of treating fractures. It effects complete immobilization of the bone fragments, allows complete mobilization of the rest of the body and yet does not retard bone healing. The method was used extensively by European surgeons during World War II. It has only recently begun to attract much attention in the United States.

Because it is probable that intramedullary nailing is the best method now available for the treatment of certain types of fractures and because its use will probably become more widespread it seemed desirable to obtain more exact information concerning its effect on fracture healing. The authors have attempted to do this by a study of experimental fractures of the dog's ulna.

Summary and Conclusions.

1. The insertion of an intramedullary wire into the dog's ulna fractured experimentally produces periosteal callus over an area often far removed from the fracture site. This callus reaches its maximum on the roentgenogram at four to six weeks and is gradually absorbed. It appears to have little effect on the healing of the fracture and is not the result of destruction of the marrow. It is postulated that this callus is caused by pressure of the wire on the inner cortex and that its disappearance is due to absorption of bone and the release of pressure.

2. Fractures of the distal half of the ulna heal more rapidly if a wire is inserted through the medullary cavity past the fracture. The more rapid union is probably due to the better immobilization which is effected by the wire and not to any callus stimulating effect of its presence.

3. It is probable that the presence of an inert foreign body in the medullary cavity does not significantly delay or speed fracture healing.

4. The deleterious effect on fracture healing produced by distraction is strikingly shown by these experiments.—*Mary Frances Vastine, M.D.*

Bettman, Ernest H., and Siffert, Robert S. Roentgen examination of the hip in Legg-Perthes' disease. *Radiology*, Oct., 1949, *53*, 548–551.

In this study the articular portion of the head

of a normal femur was sectioned into quadrants. One quadrant was removed and films made in anteroposterior projections with the femur in neutral position and with internal and external rotation. In some views the head appeared normal, in others the defect was clearly shown. To better depict the changes of the capital epiphysis four views are suggested. The three mentioned above plus a lateral. In the illustrations the process is much better visualized in the anteroposterior views in internal rotation, but in the film in routine anteroposterior projection the epiphysis is still plastic.—*J. M. Dell, Jr., M.D.*

López Engelking, Raúl. Osteitis pubis. *Rev. urol.*, México, Nov.–Dec., 1949, *7*, 317–337.

Osteitis pubis was first described by Beer in 1924. A review of the cases published since that time shows that the condition may occur secondary to prostatectomies (suprapubic, perineal retropubic), cystostomy, vaginal repair, prostatic abscess, pelvic trauma, infected hernia, pyelonephritis and symphysiotomy.

Clinically, osteitis pubis is characterized (1) by severe pain on motion and marked tenderness on palpation of the affected areas; (2) by cramps along the inner aspect of the thighs when the pubic and ischial rami are involved; and (3) by great difficulty of bending, sitting down, standing up and walking. These symptoms are attributed to the fact that the tendons of the muscles responsible for provoking them have their insertion in the symphysis, pubic rami and ischia. The author gives a tabular arrangement of all the muscles concerned by indicating the site of insertion and the respective actions.

The following is the roentgen appearance in the various stages of the disease: (1) in the earliest stage there is an irregularity of the periosteum at the level of the symphysis pubis; (2) later there is mottled rarefaction, with islands of bone simulating sequestration, which gradually extends from the symphysis to the pubic and ischial rami; (3) still later, during the healing process, there is an increase in the size, thickness, and height of the pubic rami with a definite and permanent separation of the symphysis pubis; (4) finally, after the healing is complete, there is a marked irregularity of the borders of the ischial rami associated with osteophytes and beak formations of various sizes and elevations.

The most probable cause of osteitis pubis is infection occurring either locally through Retzius' space or by the way of metastasis through the blood stream. Contributing factors are injury of the periosteum during instrumentation, pressure irritation of drainage tubes, invasion from the neighboring bladder, ureter, vagina, etc. It is noteworthy that an alarming number of cases is observed following retropubic prostatectomy, suggesting postoperative devitalization of the bone on a circulatory or nervous basis. Wheeler compared osteitis pubis to Sudeck's atrophy in other bones.

The lesion has a slow clinical course. The treatment consists of rest, local diathermy and the administration of large daily doses of vitamin B_1, over a long period.

The author presents 5 cases, 4 of which were secondary to retropubic prostatectomy. The roentgenograms in all cases are reproduced.—*T. Leucutia, M.D.*

Curr, J. F. Synovial osteochondromatosis. *Brit. M. J.*, Nov. 5, 1949, *2*, 1020–1022.

Two unusual examples of osteochondromatosis are reported. In one, the right shoulder joint showed complete lack of motion and roentgen examination showed an enormous number of loose bodies. Over 350 osteochondomata were removed from the joint space both as loose bodies and some still being attached to the synovial membrane. All loose bodies were removed and slight range of motion resulted thereafter.

In the other case, roentgen examination revealed several opaque loose bodies posterior to the ankle joint. They were found to lie in a large bursa which was excised, after which recovery resulted.

The site of reflection of the synovial membrane usually gives rise to these benign neoplasms developing from embryonic rests or from metaplastic connective tissue cells. Malignant change may rarely occur at this site. The knee, elbow, ankle, hip, and shoulder joints are involved in that order of frequency. Osteoarthritic changes are present as well.

The loose bodies do not grow by ossification but may lay down cartilage and calcify in the synovial fluid. Growth by ossification occurs only as long as attachment to the synovia and its blood supply is maintained.

Total synovectomy is the treatment of choice since recurrences are seen when the membrane remains. This is not always possible but bursae and tendon sheaths when involved usually can be completely excised.—*K. L. Krabbenhoft, M.D.*

Profitt, J. N., McSwain, B., and Kalmon, E. H., Jr. Fibrous dysplasia of bone. *Ann. Surg.*, Nov., 1949, *130*, 881–895.

The report concerns 7 cases of fibrous dysplasia of bone. The patients ranged in age from five to sixty-one years; there were 5 males and 2 females. The ribs, femur and tibia were the most commonly involved bones. In half of the cases only one bone was involved, but each affected bone contained multiple cystic areas. Disability and tenderness over the involved areas were the commonest symptom. Three patients of the 7 exhibited abnormal areas of pigmentation of the skin, but none of the patients had signs and symptoms conforming strictly to Albright's rigid criteria for the diagnosis of polyostotic fibrous dysplasia.

Roentgenographically the lesions were irregular areas of cystic rarefaction which varied greatly in size and shape, and showed bony trabeculae projecting into the areas of increased radiability. There was expansion of the bone about the lesions, with thinning of the cortex around all lesions over 5 mm. in diameter.

Exploration of the bone revealed solid tissue, varying in color from white through yellow to reddish-brown, depending upon the amount of hemorrhage. Microscopically the tissue consisted essentially of connective tissue and osteoid. The areas of new bone formation ranged from acidophilic osteoid to adult calcified bone. The lesions could be differentiated microscopically from giant cell tumor, but not from solitary bone cyst or osteitis fibrosa cystica. Follow-up studies indicate that the lesions of fibrous dysplasia may remain unchanged for many months or years and that healing of the involved bone occurs after curettage of the fibrous tissue. In the cases presented, there has been no evidence of recurrence or of malignant transformation at the sites of the original lesions.—*Harold Fulton, M.D.*

Brailsford, James F. The diagnosis of bone tumours. *Lancet*, Nov. 26, 1949, *2*, 973–975.

The value of biopsy in arriving at an accurate diagnosis in bone tumors is weighed against clinical observation aided by serial roentgenographic studies. The risks and limitations of biopsy are listed as follows: (1) the necessity of an anesthetic; (2) the necessity of cutting into the lesion—an explosive effect; (3) the reaction of trauma is added to that of the disease; (4) the removal of bony scaffolding which may seriously interfere with the resolution and stability of the affected bone; (5) a reliable opinion cannot always be formed from the provided material; (6) biopsy may actually delay surgical treatment.

On a mistaken interpretation, a limb may be amputated for a lesion which would have resolved if left undisturbed. Though clinical observation and serial roentgenography may involve some delay, there is little reason to suppose that more immediate treatment would improve the patient's chances of survival if his lesion is malignant.—*C. N. Borman, M.D.*

Balli, Luciano. Contributo alla patologia e alla clinica del granuloma eosinofilo osseo. (A pathological and clinical contribution to eosinophilic granuloma of bone.) *Ann. radiol. diag.*, 1949, *21*, 263–278.

A case of eosinophilic granuloma of bone is reported in a boy aged three. A pathological fracture of the humerus was responsible for the symptoms in this patient. Further roentgen studies revealed an osteolytic cystic area in the left ischium. Later in the course of the disease a similar type of lesion developed in the skull. The disease ran a benign course.

Treatment consisted of curettement of the cystic area in the humerus and packing of the resultant cavity with bone chips. Later a moderate dose of irradiation was given. This lesion in the humerus became self limited and regressed slowly. The lesion of the ischium healed spontaneously.

In discussing the microscopic sections and histopathology of the disease the author expounds the concept advanced by Farber of the relationship of eosinophilic granuloma with Letterer-Siwe and Hand-Schüller-Christian disease.

Included is an excellent review of the European and American literature on eosinophilic granuloma of the gastrointestinal tract, of the skin, of the lung, Löffler's syndrome and of bone. The article is illustrated with films and numerous photomicrographs.—*P. E. Russo, M.D.*

Pokorná, Lilly. Das Röntgenbild der Osteoporose im Konzentrationslager Theresienstadt. (The roentgen appearance of osteoporosis in the Theresienstadt concentration camp.) *Radiol. clin.*, Nov., 1949, *18*, 360–370.

This article was written in a concentration camp, there being no available medical literature for reference. The author was in charge of

the roentgen division of the general hospital of the camp. The reproduction of the roentgenograms salvaged from the SS which are used for illustration in the article was made at Dr. Rafael de Barros' clinic in São Paulo.

The period of observation extended from March, 1942, to July, 1945, thus including four winters. At the beginning the patients referred for roentgen examination of suspected osteoporosis or osteomalacia were usually old people around the seventies, the average age being 67½ years. Toward the end of the second winter this average fell sharply. The greatest number of cases was observed in April, then there was a gradual drop until July, no further cases being seen until the late fall. Despite the fact that many of the older people died in the interim, the highest incidence of the third winter was already reached in February. After this period it was impossible to follow through this seasonal relationship. The cases afflicted with osteoporosis became so numerous that a clinical diagnosis was ordinarily considered sufficient and only rare cases were referred for roentgen examination. In the fall of 1944, about 26,000 younger people were transferred to the extermination camp of Auschwitz. This reduced the camp population to 11,076 persons of which 3,273 were over sixty-five years of age. A rise in the average age of those presenting themselves for roentgen examination was immediately noted and the peak of incidence in the fourth winter was already reached in January.

The changes observed in the roentgenograms could be divided into two main groups: (1) structural, characterized by a poor calcium content, rarefaction of the trabeculae and considerably decreased opacity of the bone; and (2) morphologic, consisting of such deformities as a bell-shaped thorax which usually was bilateral, flattening of the pelvis, with greatly reduced conjugata vera down to 4 cm. and marked form changes of the spinal column leading not infrequently to compressed vertebrae and even true kyphosis.

According to Pokorná the occurrence of kyphosis as a sequela of osteoporosis was observed for the first time in the Theresienstadt concentration camp. Another new observation was the insidious development of a fracture in the inferior ramus of the pubic bone which most frequently was unilateral but may be bilateral. This "insidious fracture" is the result of the combined effect of weight bearing and muscle pull on a gradually demineralized pelvis. It may have some similarity to the fracture formerly described by the author in the aseptic necrosis of the os lunatum. No histopathologic study of the process could be made.—*T. Leucutia, M.D.*

Oosthuizen, S. F. Yaws. *Brit. J. Radiol.*, May, 1949, *22*, 276–279.

Yaws is a tropical disease which has many features in common with syphilis, including the bacteriologic and clinical aspects. Its osseous manifestations occur in the tertiary stage, there usually being a history of florid secondary lesions in childhood.

The most common sites of bone involvement in order of frequency are the tibia, inner end of the clavicle and upper limbs. Hands and feet are frequently affected and skull lesions are not uncommon. A periosteal reaction may develop as early as a few months after infection and the periosteal new bone is usually laid down parallel to the bone shaft. Bone erosion quickly follows the periosteal involvement. The erosions are usually multiple and present clear-cut margins. In the skull, in particular, the erosions may resemble a bone cyst, but are frequently surrounded by sclerotic bone. Joint involvement is not common.

The finding of localized erosion with sclerotic surrounding bone and nearby periosteal new bone formation may present an appearance very similar to that of syphilis. Soft tissue swelling may occur over the affected area and give the clinical impression of sarcoma.—*Harold Fulton, M.D.*

Gillespie, H. W. The significance of congenital lumbo-sacral abnormalities. *Brit. J. Radiol.*, May, 1949, *22*, 270–275.

The author studied the roentgenograms of the spines of 500 patients submitted to laminectomy for intervertebral disc protrusion and compared these with the appearance of the spines of 500 "normal" subjects. Several interesting facts were thus elicited. In 82 (16.4 per cent) of the laminectomies there were transitional lumbosacral vertebrae; only 16 (3.2 per cent) of the other series showed this anomaly. There was a much higher incidence of 6 lumbar vertebrae in the disc series than in the normals. Spina bifida involving L_5, S_1, or S_2 occurred in 91 (18.2 per cent) of the laminectomy cases, while it was found in only 24 (4.8 per cent) of the non-operated cases.

Roentgen evidence of well marked decrease in intervertebral spacing was present in 54

(59.3 per cent) of the 91 cases showing spina bifida, leading to the assumption that these defects are predisposing to disc prolapse.

A survey of 1,000 cases of patients complaining of backache or sciatica revealed spondylolysis or spondylolisthesis in about 10 per cent.

The conclusions to be drawn from the somewhat defective adaption of the human spine to the upright gait are that the various mechanical and traumatic strains make themselves most felt at the lumbosacral region. In the absence of any roentgenographic evidence of disease of the spine or of the intervertebral discs, congenital defects of the spine can be considered as factors predisposing to such disease.—*Harold Fulton, M.D.*

Rosselet, Edouard. Contribution à l'étude de la vertebra plana osteonecrotica, maladie de Calvé. (Contribution to the study of vertebra plana osteonecrotica, Calvé's disease.) *Radiol. clin.*, Nov., 1949, *18*, 371–391.

The first observation of this disease was presented by Calvé at the annual meeting of the British Orthopedic Association in September, 1924. The case was subsequently published under the title: "On a peculiar affection of the vertebral column in children simulating Pott's disease: infantile vertebral osteochondritis."

Since that time about thirty additional publications have appeared, of which only twenty dealt with undoubtedly proved cases. Because of this rarity of the condition the author presents his experience with a case which was studied by means of repeated roentgenograms over a period of more than five years. He also advances a new theory in regard to the pathogenesis of the disease.

Originally Calvé considered that the following five signs are necessary to establish the diagnosis of this new clinical entity: (1) only one vertebra is affected and there is only one pedicle present; (2) the adjacent intervertebral discs are intact; (3) cartilaginous new formation fills the space between these discs and the very thin central osseous lamina; (4) the opacity is more pronounced than that produced by the normal bone, indicating increased osseous density; and (5) there is evidence of regeneration of the osseous nucleus. Furthermore, Calvé expressed the opinion that there is a relationship between this infantile vertebral osteochondritis, which occurs during the first childhood, and Calvé-Legg-Perthes disease or infantile osteochondritis of the hip (coxa plana).

Through the subsequent publications it was proved (1) that not infrequently several vertebrae may be involved concomitantly and (2) that the affection may even extend to other bones such as the bones of hip, shoulder, and skull.

In the author's case, that of a boy four years of age, there was an involvement of L2, with decalcification of L1 and L3 and a localized osteoporosis of the frontal bone. The case is described in considerable detail. The first symptoms, consisting of pain in the back, irritability and difficulty in walking appeared following a relatively mild trauma. In the beginning a diagnosis of compression fracture of L2 was made. Three months later, it was considered that the fracture had healed but because of the persistent pain and difficulty of walking, the child was sent to a mountain resort (Prof. Rollier's Clinic at Leysin). As a result of complete immobilization in alternating decubitus, calcium and vitamin D medication, and intensive heliotherapy, he made a complete recovery within a few months. Five years later he enjoyed normal health. Serial roentgenograms were made during the entire follow-up period and in retrospect a final diagnosis of vertebra plana was made.

Several sets of the roentgenograms are reproduced and the findings described in extenso. The differential diagnosis includes (1) fracture; (2) vertebral tuberculosis; (3) non-tuberculous spondylitis, especially osteomyelitis; (4) malformations due to aberrations in blood supply or faulty development in the region of the chordal canal; (5) diseases of the hemopoietic system (6) primary tumors; (7) secondary tumors; (8; tumors from the neighborhood; (9) endocrine diseases; (10) Schüller-Christian disease and Gaucher's disease; (11) eosinophilic granuloma of bone and Scheuermann's disease (painful juvenile kyphosis).

Calvé assumed that the condition develops under an influence which is either of infectious or endocrine origin and therefore used the term of "osteochondritis." Later, however, the opinion prevailed that an aseptic necrosis due to vascular thrombosis, aseptic embolus, trauma, etc., constitutes the fundamental change and the terms of vertebra plana (Harrenstein) or vertebra osteonecrotica were suggested.

The author evolves a new theory of pathogenesis placing the main burden on the intervertebral disc. If there is a "locus minoris resistantiae" in the osseous structure of the vertebral body, the expanding nucleus pulposus of the adjacent intervertebral discs will exert

a progressive pressure. Sandwiched between the forces from opposite directions at an age when the turgescence of the intervertebral disc is at its maximum the osteomalacic vertebra will be gradually flattened to a very thin lamina. A similar mechansim is observed in senile osteoporosis, osteomalacia, Paget's disease and occasionally in Recklinghausen's disease.

The prognosis is good. All cases recover completely. In exceptional instances a slight scoliosis persists, but without producing functional disorders.

The author proposes that the condition be called vertebra plana osteonecrotica, Calvé's disease.—*T. Leucutia, M.D.*

GENERAL

Ulfelder, Howard. Exfoliative cytology. *New England J. Med.*, Aug. 11, 1949, *241*, 236–240.

As an adjunct in tumor diagnosis, exfoliative cytology, the study of cells desquamated from body surfaces, has recently proved its value. Accuracy varies with the experience of the observer, the care in preparation of stained material, the number of smears examined per patient, and the nature of the clinical material. Details of collection, fixation, and staining must be meticulously observed, and interpretation should be attempted only by those with special cytologic training who are in a position to maintain and improve their accuracy by constant practice.

In the female genital tract, cytologic accuracy approximates 90 per cent for patients with carcinoma of the cervix, and between 80 and 90 per cent for carcinoma of the fundus. The method can detect extremely early cervical cancer, and a number of pre-invasive carcinomas (carcinoma in situ) have been reported. The vaginal smear after radiation therapy shows characteristic effects on both normal and malignant cells. Radiation response as evaluated by cytologic criteria correlates well with tumor behavior, and the method offers prognostic aid in cervical cancer treated by radiation. Repeated cytologic check on such patients may show persistent or recurrent disease.

Cytologic examination of sputum or bronchoscopic aspiration in patients with carcinoma of the lung has shown accuracy approaching 90 per cent in some hands. Cytologic diagnosis in the upper gastrointestinal tract presents special difficulties, as the gastric fluid is less viscid, and digestive ferments rapidly destroy desquamated cells. Satisfactory preparations are impossible in the presence of obstruction or gastric retention. Aspiration of stomach content should be aided by roentgenologic positioning of the tube, to be certain of obtaining a sample from the distal third of the stomach where gastric carcinoma is common. Most observers have reported about 30 per cent accuracy in patients with proven gastric carcinoma. However, one small series, using a special tube with multiple openings, through which physiological saline solution was passed into the stomach to obtain a representative sample from the entire organ, demonstrated malignant cells in 10 out of 12 patients with carcinoma of the stomach.

From 55 to 75 per cent accuracy in patients with carcinoma of the urinary tract has been reported. Occasionally, benign papillomas are responsible for false-positive diagnoses. Prostatic secretion smears have yielded accuracies of over 85 per cent in patients with cancer of the prostate.

Cytologic examination of fluid in serous cavities has long been established as an aid in cancer diagnosis. Diagnostic criteria are based on clusters of tumor cell in a recognizable architecture, rather than on individual cell cytology. Accuracy in patients with cancer of serous surfaces has approximated 70 per cent. Other materials being investigated for cytologic tumor diagnosis include rectal swabbings, duodenal aspirates, spinal fluid, and the ocular humors.

Exfoliative cytology can demonstrate the presence of cancer in many organs, even when the lesion is grossly invisible or histologically non-invasive. Results are most accurate when slides are meticulously prepared by interested personnel and interpreted by one specially trained in exfoliative cytology. Even under the best conditions, false-negative and false-positive reports will be encountered. False-positive reports carry the danger of institution of radical therapy without securing confirmatory evidence. The danger of false-negatives is potentially more profound, in giving an unwarranted sense of security to the patient and physician. One important limitation of the method is its essential inability to precisely localize tumor masses. For example, in a patient with malignant cells in the sputum and a small area of consolidation on the chest roentgenogram, only the laws of probability permit assumption that that area is the source of the demonstrated cells. It is therefore important to discriminate carefully in choosing between surgical procedures for confirmation and localization, and surgical procedures for cure.—*H. P. Brean, M. D.*

Montejo, Gustavo. Enfermedad de sistema como concepto y como realidad clínica. (The concept and clinical reality of systemic disease.) *Bol. Inst. Nac. de Radium* (Bogotá, Colombia), March-July, 1949, *1*, 253–494.

This article deals in lengthy detail with those neoplastic formations which, owing to their way of generalization, may be considered à priori as systemic diseases.

The classical forms of dissemination of malignant tumors are: permeation, emboli through the lymphatic and blood streams and perineural spreading. There are, however, a number of lesions as for example lymphosarcoma, Hodgkin's disease, sarcoidosis, mycosis fungoides, etc., in which the metastases are difficult to explain on the basis of any of these patterns.

The author advances the theory that one may consider as systemic all those pathologic processes which have their seat in the actual or potential macrophagic (reticular) system and are capable of producing multiple foci. The actual reticular system is histologically composed of primitive or macrophagic reticular cells enmeshed in a fine network of reticulin fibers, while the potential reticular system is assumed to consist of undifferentiated mesenchymal cells which may produce reticular cells in any part of the body.

The functions of the reticular system include: (I) functions of defense: (*a*) phagocytosis, (*b*) formation of antibodies, (*c*) formation of granulomas, which is a reactive process to an irritating agent (tuberculosis, Boeck's sarcoid, Hodgkin's disease); (II) function of reproduction (cytopoesis) counting among its derivatives the lymphocytic, granulocytic, erytrocytic, thrombocytic and plasmocytic elements; (III) metabolic functions: (*a*) proteids, (*b*) lipids, (*c*) glucose, (*d*) vitamin A and perhaps vitamin D, (*e*) iron and pigments of hematic origin; (IV) diatonic function, although this is questionable; and (V) function of anticancerous defense which likewise is debatable.

After discussing the evolution and morphologic adaptation of the reticular system, the author suggests the following classification for the various neoplastic or tumor-like formations originating from this system:

(a) derivatives of plasma cells:
  (1) multiple myeloma and plasmacytoma
  (2) plasma-cell leukemia
  (3) intermediary forms of diffuse medullary plasmocytic infiltration

(b) derivatives of macrophages: The nonspecific reticular cell gives origin to
  (1) tumor-like granulomatous processes, including Hodgkin's disease, Besnier-Boeck's granulomatosis, mycosis fungoides, and to
  (2) true tumor formations, including reticulum cell sarcoma with its undifferentiated, mature and polymorphous cell varieties and the giant-follicular lymphoblastoma. The reticulo-endothelial cells give origin to reticulo-endothelial sarcoma which in bone is known under the name of Ewing's tumor. The histiocytic-monocytic chain originates in
  (1) monocytic leukemia, and
  (2) histiocytic cell sarcoma.

(c) blood derivatives: from the lymphon
  (1) the small lymphocyte is the structural element of lymphocytoma,
  (2) the medium and large lymphocytes form the basis of lymphoblastic lymphosarcoma
  (3) the medium and small lymphocytes also form the basis of lymphoid leukosis, lymphoid leukemia and aleukemic leukemia.

  from the myelon:
  (1) chloroma
  (2) myeloblastoma
  (3) myeloid leukemia.

  from the erythron
  (1) erythremia.

The author discusses the clinical aspects and roentgen treatment of lymphosarcoma, reticulum cell sarcoma, giant-follicular lymphoblastoma, Hodgkin's disease, and multiple myeloma using a total of 26 cases as samples. The records of all these cases are presented in detail.—*T. Leucutia, M.D.*

RADIATION THERAPY

Renfer, H. R. Kombination von klinischer Behandlung mit Röntgenbestrahlung. (Combination of clinical therapy with roentgen irradiation.) *Radiol. clin.*, Sept., 1949, *18*, 306–313.

The author discuses the value of the different auxiliary agents which are used at the present time in association with roentgen irradiation. Two questions are raised: (1) Does the combined treatment lead to an intensification of the desired effects and, (2) Can we influence through the action of the cytostatic drugs in a favorable manner the progress and spreading of the disease?

The following preparations are surveyed: arsenic, urethane, nitrogen mustard, thiomidil, colchicine and the hormones.

On the basis of a systematic use and control

in a limited number of patients the author arrived at the conclusion that there is a definitely favorable effect from the combined treatment. On the one hand, there is an intensification of the roentgen action on the tumors (nitrogen mustard, hormones, ultrasonic rays); on the other, there is an inhibitory influence on the dissemination and progression of the disease (nitrogen mustard, urethane). The usefulness is restricted to those types of tumors which are characterized by a high degree of radiosensitivity. The most effective of all agents is nitrogen mustard which in selected cases permits the corresponding reduction of the roentgen dose. Presently this is the only preparation which may be considered as being able to replace irradiation to a certain extent. Urethane proved very unsatisfactory. The administration of stilbestrol in large doses in seminoma led to marked stimulation of the tumor growth. On the other hand, perandren produced a notable retardation of osseous metastases in primary carcinoma of the breast although a repair of the destroyed areas could not be obtained. A favorable effect was observed from a combination of thiomidil and roentgen irradiation in struma malignum but further study is necessary.

The internal administration of colchicine is discouraged because of its marked toxicity. The external application, in the form of a 1 per cent salve, however, is of some benefit in ulcerated surface tumors, as for example carcinoma of the breast, which have become radiation-fast.

The combination of ultrasonic and roentgen irradiation had an unfavorable effect in a case of inoperable mammary carcinoma. Extensive local ulcerations and the rather sudden onset of widespread metastases were observed.

It is probable that the statistics of the final results will be very little influenced by the addition of any of the above mentioned auxiliary agents. Nevertheless, prolongation of life is possible in individual cases.—*T. Leucutia, M.D.*

Cantril, Simon T., and Buschke, Franz. The clinical usefulness and limitations of supervoltage roentgen therapy. *Radiology*, Sept., 1949, *53*, 313–330.

Because of the reduced backscattering in the tissue a more homogeneous beam throughout the irradiated region may be obtained with supervoltage roentgen rays. As a result (1) the size of the field does not need to be increased to increase the scattered component of the depth dose, (2) undesired irradiation of normal or previously irradiated tissues may be decreased, (3) the ratio of energy absorbed by the tissues to the total absorbed by the body is increased resulting in improved tolerance to high voltage irradiation, (4) there is decreased skin damage, and (5) because of the increased penetration and decreased skin damage certain lesions can be irradiated using only one field.

Cancers not responsive or poorly responsive to ionizing radiation will not respond better to more penetrating rays. Gamma rays give no better response than roentgen rays from 200 kv. (peak). The most one can hope for is some improvement in the results in those forms of cancer which are radiosensitive to medium voltage therapy. In the great majority of cancers biologically responsive to irradiation the results with 800 kv. (peak) are not superior to those obtained with medium voltage. In a small group of deep-seated tumors such as those of the bladder and esophagus it is probable that supervoltage irradiation will increase the survival rate. The writers treated with roentgen rays generated at 800 kv. (peak) 61 cases of cancer of the bladder, 9 of whom remained clinically free of disease for over five years. It was possible to give a tumor dose of 5,000 to 6,000 r in six to eight weeks resulting in initial bronzing of the skin with subsequent incomplete epilation and a very minimal subcutaneous fibrosis. In 8 cases of carcinoma of the esophagus subjected to massive therapy, in all but one an initial opening of the lumen was obtained. Only one was symptom-free and roentgenographically free of the disease eight years later.

The writers have also treated a variety of accessible cancers such as of the pharynx, tonsil, base of the tongue, larynx, lip, etc. In certain of these cancers a one-field technique was used. With the possible exception of carcinoma of the base of the tongue, the results were no better in other forms of epidermoid cancer of the head and neck than those obtained with medium voltage irradiation.

Where massive dosage is required supervoltage irradiation will give less morbidity. In a small percentage (not exceeding 10 per cent of all cancers to be treated) supervoltage may produce a cure when medium voltage therapy would not. The writers state that with 800 kv. (peak) they can introduce into a susceptible tumor, regardless of location, a dose sufficient to control a malignant growth so far

as dose alone is concerned. Some cancers cannot be controlled because of the biological limitations of the normal tissue sensitivity.—*J. P. Bennett, M.D.*

Breitländer, K. Thymustod nach Röntgenkleinraumbestrahlung. (Thymic death following roentgen irradiation of a small area.) *Strahlentherapie*, Dec., 1949, *80*, 569–571.

An eleven month old girl had received two previous roentgen treatments with a Chaoul tube at a short focal-skin distance without ill effect. The treatments were given to two hemangiomas, one in the posterior cervical region and the other in the lumbar area. The former was as large as a thumb nail and the latter was 3.5 cm. in diameter.

After an interval of six to seven weeks the patient received another similar treatment and was found dead early the next morning. The attending physician classed the death as a thymic death. A post mortem roentgenogram showed thymic hyperplasia and at autopsy the thymus gland weighed 40 gm.—*H. G. Moehring, M.D.*

Ellis, Frank and Stoll, Basil A. Herpes zoster after irradiation. *Brit. M. J.*, Dec. 10, 1949, *2*, 1323–1328.

The authors attempt to support their clinical impression that irradiation can cause herpes zoster by presenting 45 cases of their own and by reviewing the literature. Statistically this is difficult to prove because the incidence of herpes zoster in the general population is not known.

Pathologic studies of herpes zoster have been reported as showing chiefly posterior spinal root ganglion lesions but occasional instances of primary involvement of the gasserian ganglion, the geniculate ganglion, the posterior root itself, the posterior horn or the anterior branch of an intercostal nerve have been found. There is evidence suggesting that the virus of chicken pox is identical with that of herpes zoster.

Cases have been reported indicating a relationship between malignancy and herpes zoster of adjacent somatic segments but apparently radiation has not been previously suggested as a cause. The reported incidence has varied from 0.64 per cent to 13.4 per cent, the over-all incidence being under 5 per cent.

The authors' series includes 24 irradiated cases of carcinoma of the breast, 15 of malignancies other than breast and 6 of benign lesions. In only 8 of the 45 cases was there evidence of either primary or metastatic spinal disease.

Maximal incidence of herpes zoster was at the somatic level of the areas irradiated and involved with a slight preponderance the ipsilateral half of the body. The peak incidence was from three to nine months after irradiation with a spread of from one to 144 months. This peak incidence is in agreement with other reported cases. Those cases occurring after twenty-four months might well be coincidental

The authors postulate that irradiation causes gliosis and vascular impairment in the posterior nerve roots and fibrosis of the skin with consequent irritation of nerve endings. These phenomena might cause activation of a latent zoster virus. The time relationship (3–9 months) is explained as that required for the irritating factors to occur. The low incidence may be due to immunity, minimal fibrosis or absence of a latent virus in the individual case.—*H. J. Klos, M.D.*

Helmke, Roderich. Über individuelle Unterschiede der Röntgenstrahlenempfindlichkeit der menschlichen Haut, geprüft an der Erythemschwelle. (Individual differences in sensitivity of human skin to roentgen rays, determined by threshold erythema.) *Stralentherapie*, Dec., 1949, *80*, 585–590.

In each of 100 individuals (50 men between the ages of 25–45 years and 50 women between the ages of 20–40 years) with normal skin, ten 1.5 by 1.5 cm. dorsal areas were exposed to roentgen radiation from a Chaoul contact tube under standard conditions. The doses to each area differed in steps of 25 r from 175 r to 400 r. Inspection seven hours after irradiation revealed the *early* erythemas; after fifteen days the erythema thresholds of the *main* reaction were determined.

Exclusive of several extreme high and low values, the range of individual variations for threshold erythemas were 100 r for the *early* erythema and 50 r for men and 75 r for women for the *main* reaction. In old individuals (over 70) and in those aged sixteen years or less, the same range of variations existed, though the sensitivity to radiation was less (the number of test individuals was too small in the old and young groups to permit any real judgment, however).—*H. G. Moehring, M.D.*

Reichel Wolf S. Die Röntgentherapie des Schmerzes. (Roentgen therapy of pain.) *Strahlentherapie*, Dec., 1949, *80*, 483–534.

Two hundred fifty-three cases of painful disease of various etiologies were treated and evaluated; the 500 case total of a ten year period of treatment and observation was decreased to this number by the exigencies of the war. Improvement (measured largely subjectively in the face of such factors as ability to work or serve in the military forces in war time) was attained in 82 per cent of the cases with 55 per cent showing *considerable* improvement or even healing.

Roentgen therapy yielded the best results and proved itself a specific method of treatment in the neuralgias and arthroses with 86 per cent and 87 per cent improvement and 67 per cent and 60 per cent considerable improvement or complete healing respectively. (The arthrosis considered here is the hypertrophic form resulting from senile, static and degenerative changes without any element of infection.)

The treatment technique was varied moderately about an average of 160–180 kv., with a half-value layer of 0.65 mm. Cu; 30–40 cm. focal-skin distance; 20 r per minute; and a skin dose adjusted to give a tissue dose of approximately 75 r in the neuralgias and 45 r in the arthroses. Field size varied from 6 by 8 cm. for the gasserian ganglion to 10 by 15 cm. for plexus neuralgias. Sciatica was treated through both a spinal nerve root field and through nerve-trunk fields at the most painful peripheral points.

Chronic rheumatic polyarthritis does not respond well enough to warrant using roentgen therapy. A small series of peptic ulcers with painful complications was treated without satisfactory improvement.

A review of the physiology of pain, of previous clinical experiments and results, and an extensive consideration of the several theories of the effect of radiation on pain (mechanical, nervous, enzymatic and electrochemical) introduces the paper.—*H. G. Moehring, M.D.*

Bachman, Arnold L., and Harris, William. Roentgen therapy for pituitary adenoma; correlation of tumor dose with response in 64 cases. *Radiology*, Sept., 1949, *53*, 331–341.

The authors report the results of irradiation of 64 cases of pituitary adenomas, varying the technique as to (1) total dosage, (2) the number of courses of treatment given, (3) the treatment period for each series and (4) the over-all time for multiple courses. The physical factors factors were fairly uniform. These were 180 to 200 kv.; 0.5 mm. Cu and 1 mm. Al to Thoraeus filter. In most cases three fields were employed.

Irradiation of pituitary adenomas does not result in destruction of the adenomas. The size of the tumor is decreased and its growth potential diminished in a high per cent of the cases. The criterion of success with irradiation is based upon the amount of clinical improvement. Twenty per cent of the lesions treated in the series were cystic—radioresistant. The remainder varied greatly in radiosensitivity. Of 38 cases of chromophobic adenomata 19 (50 per cent) responded satisfactorily to the first course of roentgen therapy. Eleven of those failing to respond were re-treated, of which 3 gave satisfactory response. Of 21 cases of eosinophilic adenomas 8 (38 per cent) responded satisfactorily to the first course; of the remainder, 9 were re-treated, of which only 1 responded well. Of 5 cases of basophilic adenomas treated, 4 responded adequately to irradiation. The rate of recurrence was low. In 5 cases (16 per cent) which had responded well to the first course there was recurrence after several years which again responded well to re-treatment.

Where there had been no response with heavy irradiation at first, further irradiation was of no avail. Thus there was a marked difference in response between tumors treated initially and those re-treated after an unsatisfactory course. Only in a minimal number of cases would re-treatment bring improvement. In a number of cases where the initial dose was small (up to 2,500 r) there was further improvement obtained with additional treatment within a short time; it these cases a greater dose could, instead, have been given at first. No further improvement was noted with re-treatment if the initial dose was over 3,000 r. This does not refer to recurrences.

The authors' data suggest that an optimum tumor dose of 3,000–4,000 r be delivered in thirty to forty-five days. In such case retreatment brings no further improvement. Surgery is indicated where the first series fails. In more advanced cases doses up to 6,000 r may be warranted, these cases giving the poorest results with surgery. The authors compare the results obtained with single-course and multiple-course technique. The former gave

earlier results with lower total dosage probably due to tissue recovery.—*J. P. Bennett, M.D.*

Baclesse, F. Les épithéliomas du sinus maxillaire supérieur (à l'exclusion de ceux de l'éthmoïde et des fosses nasales); importance de la classification topographique; résultats éloignés obtenus par roentgenthérapie seule. (Epitheliomas of the maxillary antrum [exclusive of the ethmoids and the nasal cavities]; importance of the topographic classification; late results obtained by roentgen therapy alone.) *Bull. Assoc. franç. l'étude cancer*, Dec., 1949, *36*, 277–284.

The paper reviews 115 cases of malignant tumors of the maxillary antrum seen at the Curie Foundation from 1929 to 1944. The tumors originating in the ethmoid cells or nasal cavities have been excluded from the study. The advanced cases originating at the junction of the maxillary and ethmoid sinuses are hard to classify.

Baclesse emphasizes the usefulness of the topographic subdivision of the tumors for several reasons (*a*) the metastatic spread depends upon it; (*b*) the radiotherapeutic response is different; (*c*) there are histological predilections for the various sites.

He proposes the following classifications: (1) Epithelioma originating in the infra-structure (45 cases) of the maxillary sinus. Roentgenographically the alveolar ridge is destroyed and there is invasion shown on tomograms of the bottom of the sinus. They can be easily confused with tumors of the alveolar ridge which have extended upward. (2) Epithelioma of the supra-structure (19 cases) extending in the direction of the malar bone or along the floor of the orbit. Those which have invaded in the direction of the floor of the orbit and posterior wall have a worse prognosis. (3) The tumors (9 cases) which have proliferated along the whole lining of the maxillary sinus and which last a long time before they will invade any of the bony structures. (4) Tumors of the medial wall which straddle over the nasal cavity. They are often of unusual histopathology. (5) Tumors originating in the superomedial angle of the sinus at the junction with the ethmoids. Even the moderately advanced cases are hard to differentiate from those originating in the ethmoid sinuses.

Baclesse points to the importance of tomograms and the roentgen examination in the submental view to determine the extent and location of the bone destruction. The submental roentgenogram is particularly useful in case of invasion of the posterior wall.

Of 103 patients with malignant tumors, 45 were treated by roentgen therapy alone with at least five year follow-up. Of these, 14, or 33 per cent, were free from symptoms after five years. The best results were obtained in those originating in the infra-structure. As for other sites of the body the presence of metastatic nodes diminishes the percentage of cure. The technique consists of three fields, one lateral, one anterior on the diseased side, and a lateral coming from the opposite side. The treatment is fractionated over a period of from six to nine weeks, the total skin dose per field being in the neighborhood of 4,000 r.—*G. H. Fletcher, M.D.*

Burkell, C. C. Cancer of the lip. *Canad. M. A. J.*, Jan., 1950, *62*, 28–33.

This is a statistical analysis of 534 biopsied cases of carcinoma of the lip treated mainly radiologically at the Saskatchewan Cancer clinics. The sexual preponderance and the location are in agreement with the literature (98.6 per cent in men, 97 per cent on the lower lip). All but 5 of the lesions were read as squamous cell carcinoma, the others being intra-epidermal carcinoma, carcinoma in situ, basosquamous carcinoma and basal cell carcinoma.

There were pre-existing chronic lesions in 24.5 per cent (chronic ulcer, leukoplakia, keratosis or chronic epithelial hyperplasia). Using the Holt Radium Institute method of classification, 90.1 per cent were in Stage I (lesion under 3 cm. with no impaired mobility) and 0.5 per cent were in Stage IV (distant or extensive regional metastases).

Treatment of the primary lesion was mainly with roentgen rays (115) and radium implants (349), the remainder (70) being radon application and surgery. The five year cure rate for the original treatment was 89.5 per cent (eliminating these cases which were lost or have died of other causes). Radium implants gave a cure rate of 91 per cent while roentgen irradiation gave 85 per cent, but there was a slight preponderance of more advanced cases in the latter group. There was a recurrence rate of 5.2 per cent (including new lesions), these being treated either by radiation or surgery.

In general, the cosmetic results with irradiation are good. Radium and roentgen therapy yield comparably high cure rates of the primary lesion but lymph node metastases should be treated surgically. Prophylactic neck dissec-

tions are not indicated because the operative mortality (5 per cent) closely approaches the incidence of metastatic nodes in this series (6.3 per cent).—*H. J. Klos, M.D.*

HAUBRICH, R. Beitrag zur Röntgentherapie der Oesophaguscarcinome. (Contribution to the roentgen therapy of esophageal carcinoma.) *Strahlentherapie*, Dec., 1949, *80*, 559–568.

These conclusions are drawn after a review of the last decade's publications on roentgen irradiation of esophageal carcinoma and a consideration of the author's own 32 cases:

A three year "cure" could not be attained.

An appreciable prolongation of life is accomplished only with high tumor doses. Below 3,000 r total dose, the average duration of life is no different than in untreated cases (eight months). With doses over 4,500 r significant prolongation of life is obtained.

Early treatment does not increase the prolongation of life, but is nevertheless to be sought because only early (when the patient's general condition is still good) can attempts at cure with 6,000 r or more be made.

Roentgen therapy accomplishes palliation by opening stenotic areas and, in the future, may well be used to improve the general condition preoperatively.—*H. G. Moehring. M.D.*

COLE, W. H., SLAUGHTER, B. P., and MAJARAKIS, J. D. Carcinoma of the thyroid gland. *Surg., Gynec. & Obst.*, Sept., 1949, *89*, 349–356.

During the past eleven and a half years the authors have encountered 54 patients with carcinoma of the thyroid out of 663 patients having thyroidectomy for nodular goiter. This constitutes an incidence of 8 per cent. The incidence of carcinoma in toxic goiter was only 1 per cent, in contrast to 17.15 per cent in nontoxic nodular goiter.

Of the solitary nodules which comprised half of the group of nontoxic nodular goiter 24 per cent were cancer in contrast to only 9.8 per cent for the multinodular type of nontoxic nodular goiter. The incidence of cancer in the authors' series of 517 patients with toxic diffuse goiter was only 0.2 per cent.

Goiter, including cancer of the thyroid, is a geographical disease. The ratio of goiter to all admissions at the University of Illinois hospitals is three times greater than in hospitals along the Atlantic seaboard.

The danger of cancer in goiter is about three times greater in men than in women. The average age of patients with carcinoma of the thyroid is much lower than the average age of patients with other types of cancer because it is so common in young people. Most carcinomas have their origin in benign nodules or adenomas as indicated by the fact that the average duration of the mass in this combined series was 6.1 years.

The preoperative diagnosis in early cases is extremely difficult. The authors have been able to make a correct diagnosis in no more than 75 per cent of patients with carcinoma.

When a cancer of the thyroid has invaded the capsule or metastasized to cervical lymph nodes, it should be treated by radical neck dissection and radiation therapy, sometimes including radon seeds. Reports of other investigators indicate that radioactive iodine will be of only slight help in controlling this disease.

The five year survival rate as reported by numerous authors varies greatly due in part to the different criteria used in making the microscopic diagnosis, and in part to geographical location. In the authors' series it was 38 per cent.

The incidence of cancer in the solitary type of nontoxic nodular goiter is so high in the Great Lakes region that the authors advise removal of all solitary nodules. They perform subtotal hemithyroidectomy rather than enucleation because early cancer will be found unexpectedly in a surprisingly large number.—*Mary Frances Vastine, M.D.*

GAHAGAN, H. Q., and YEARWOOD, H. M. Wilms' tumor; review of five year survivals in the literature and report of two cases. *J. Urol.*, Sept., 1949, *62*, 295–299.

The authors have reviewed the literature and have been able to find only 33 proved cases with five year survival. They feel that a shorter survival period does not justify consideration as a cured case. No case has been reported as dying of the disease after a five year survival.

The accepted methods of treatment are; (1) nephrectomy alone; (2) preoperative irradiation and nephrectomy; (3) nephrectomy and postoperative irradiation; (4) preoperative irradiation, nephrectomy and postoperative irradiation; and (5) irradiation alone. The highest survival rate has been in those receiving nephrectomy alone. There has been only one reported five year survival with a verified diagnosis treated by irradiation alone. The

authors tabulate the five year survivals according to treatment methods.

In the ten years from 1937 to 1947 the authors saw 15 cases of Wilms' tumor. Three patients are alive and well with no evidence of recurrence after periods of seventy-four, sixty-five, and nine months respectively. The 2 cases surviving more than five years are reported in detail. One case was treated by nephrectomy plus postoperative irradiation and the other was given preoperative irradiation followed by nephrectomy and postoperative irradiation. —*R. M. Harvey, M.D.*

Friedman, Milton, and Lewis, Lloyd G. A new technic for the radium treatment of carcinoma of the bladder. *Radiology*, Sept., 1949, *53*, 342–362.

Details of the Walter Reed Hospital technique for radium treatment of bladder carcinoma is described. The chief features of this plan are as follows: (1) Iso-irradiation of the lower two-thirds of the bladder wall with gamma radiation by means of a small radium capsule held fixed in the center of the bladder by means of a Foley or Foley-Alcock catheter. Cystotomy constitutes a part of the initial radium application, this procedure allowing accurate selection and fitting of the bag, as well as preliminary inspection of the tumor and the extent of involvement. Occasionally retrograde insertion of the catheter into the urethra is necessary by means of a string attached to the radium-containing catheter, this procedure being possible by virtue of the cystotomy. Drainage of urine is also provided. Radium treatment in this manner provides homogeneous irradiation with minimal exposure of the surrounding viscera. (2) Fractionation over a period of ten to twelve days. (3) Treatment in two sessions with an interval of three to five days. The dose is expressed as the number of gamma roentgens delivered to that portion of the bladder wall in contact with the surface of the distended bag. The average is 5,500 to 9,000 gamma roentgens, given in two sessions with a total of ten to twelve days from the first to the last treatment.

The method is particularly suitable for treatment of multiple papillary tumors and for new growths and recurrent tumors in the lower two-thirds of the bladder. The tumor must be of such configuration and size that, at cystotomy, after the bag has been inflated, the entire tumor-bearing area can come in contact with the surface of the bag. Bulky extensive tumors which are more than 3.0 cm. thick will probably not respond well to this type of irradiation.—*C. N. Borman, M.D.*

Berven, Elis G. E. Carcinoma of the vulva. I. The treatment of cancer of the vulva. *Brit. J. Radiol.*, Sept., 1949, *22*, 498–507.

Surgical treatment of carcinoma of the vulva is always more or less radical, varying from simple excision of the tumor to radical removal of the vulva and bilateral dissection of the groins. The average five year survival rate is between 22 and 25 per cent, with a primary mortality of 10 to 15 per cent. Radiation treatment yields poor results, about 12 per cent. Combined methods appear somewhat better.

The reasons for the poor results are: (1) The patients are usually old, and are in poor general condition which either prevents adequate treatment or makes the possibility of complications much more likely. (2) The tumors themselves are radioresistant, and they arise in tissues which are atrophic, have poor nutrition, and are involved with degenerative changes making healing after surgery or irradiation very slow or incomplete. (3) Metastases develop early and rapidly disintegrate.

At Radiumhemmet, since 1922 the lesions have been treated by electrocoagulation followed by teleradium irradiation and, where necessary, surgery. The malignant lesion itself and all of the usually present precancerous vulvitis are removed by coagulation, and after one week the irradiation is begun. Patients having no demonstrable metastases (Stage I) are treated, and if metastases subsequently develop they are removed surgically. In patients with operable metastases (Stage II) the irradiation is followed by surgical removal of the metastases if they have not disappeared after the irradiation. In patients with inoperable metastases (Stage III) the secondary lesions rarely become operable, but if they do, the groins are dissected.

In the group treated by this method there have been 286 patients. In Stage I the five year survival rate is 60 per cent, in Stage II, 27 per cent, and in Stage III, only 14 per cent. The rate for the five years from 1936 to 1941 was 40.4 per cent; for the whole series the five year survival rate is 38.1 per cent.—*E. F. Lang, M.D.*

Tod, Margaret C. Carcinoma of the vulva. II. Radium implantation treatment of carci-

noma vulva. *Brit. J. Radiol.*, Sept., 1949, *22*, 508–512.

The peculiar tissues of the vulva make it a poor field for radiotherapy, and surgery should be used when possible in the treatment of malignancy. Surgery permits removal of precancerous lesions which, by subsequent degeneration to malignancy, may cause the death of the patient. Certain cases, because of poor general condition, or the position of the lesion close to the urethra or in the vagina, will be more satisfactorily treated by irradiation, and this is always by radium implantation at the Holt Radium Institute, even when it is only for palliation.

According to the sites of development of carcinoma, the vulva is divided into three regions. In the anterior part, the clitoris and surrounding folds of skin, usually a single plane implantation is used, with rarely an additional two-plane implant posteriorly if the lesion is very large. In the middle section of the vulva, which includes the urethra but not the vaginal introitus, it is necessary to distinguish carcinoma of the urethra, which incidentally has been found to respond surprisingly well to irradiation with radium. When the tissues around the urethra are involved, it is necessary to use an indwelling catheter. Lesions in the middle and posterior segments of the vulva are treated in a similar fashion, using usually two-plane or volume implantations. In some cases very long needles are necessary.

Implantation is usually done under spinal anesthesia with doses of 6,000 r in seven days planned. A dressing of acriflavine in paraffin is most suitable.

Most of the cases treated are those unsuitable for surgery, and therefore since there is a high proportion of patients with late disease, the survival rate is not high. Of 116 cases, 25 per cent were alive after five years, but only 21 per cent were alive and well. Two patients who were alive died of a second malignancy which had developed in a different area of a pre-existing leukoplakia.—*E. F. Lang, M.D.*

Ellis Frank. Carcinoma of the vulva. III. Cancer of the vulva treated by radiation; an analysis of 127 cases. *Brit. J. Radiol.*, Sept., 1949, *22*, 513–520.

A series of 127 cases of carcinoma of the vulva treated with roentgen rays, radium, surgery, or a combination is reported. All but one is over forty years of age and the age of maximum incidence is sixty to sixty-nine. The vast majority of lesions were squamous cell carcinoma. The radium treatments were surface applications, single plane or two plane parallel implants. Doses were between 5,000 and 6,000 r in five or seven days. The roentgen treatment was given either in a single dose or in a course of several treatments. More than half had radium as the primary treatment.

Although the five year survival rate is 28 per cent, the figure at ten years is only 11 per cent, indicating the inadequacy of the five year figure. The cases are all analyzed according to the survival period, the type of treatment, the cause of death, and the location of malignant tissue at the time of death, in addition to the complication of the various modalities.

The author concludes: (1) Radium is not a satisfactory way of treating the primary lesion. It is useful in treating recurrences after surgery. (2) Surgery is not a satisfactory method since it is followed by a high recurrence rate, but there is less pain and trouble to the patient. (3) Excision of glands as soon as they are considered clinically involved is desirable.—*E. F. Lang, M.D.*

Mandicas, A. Traitement des fistules recto-vaginales consécutives à la curieradiothérapi du cancer du col utérin. (Treatment of recto-vaginal fistulas following curie-roentgen therapy of cancer of the uterine cervix.) *Gynec. et obst.*, Jan., 1950, *49*, 72–76.

The author deals with surgical treatment of rectovaginal fistulas, following radiation therapy which has been successful in causing disappearance of malignant new growth. He has not attempted to treat surgically those lesions in which the cancer persists.

Fistula is only an element of a stenosing and ulcerating rectal lesion, resulting from action of radium and roentgen rays on the coats of the rectum. Furthermore, the destructive action of radiation on all tissues of the region is of long duration so that after many years these tissues are incapable of forming normal scar tissue. Treatment by usual procedures used for repair of traumatic and obstetrical fistulas in this region are unsuccessful.

The author has developed a method of repair which he believes is superior to classical procedures. He points out that the classical procedures have been constant failures because the sutures will not hold. He performs an intrasphincteric amputation of the anus and re-

moves part of the anal canal, all of the involved tissues of the vagina and rectum, following which he draws down the upper rectal stump and sutures it to the anal tegument.

He cites 2 cases. The first had had five previous surgical procedures, all of which had failed between December, 1946, and October, 1947. The author operated on her in April, 1948. There was a small fistula which persisted for some time but finally closed, and in November, 1948, the patient had no evidence of fistula or lesion but she still had some anal incontinence. The second case had had no previous operations and she obtained a perfect result.

The author feels that this method is worthy of more widespread employment.—*Angus K. Wilson, M.D.*

Schumann. Beiträge zum Cervixsarkom. (Sarcoma of the cervix.) *Strahlentherapie*, Dec., 1949, *80*, 577–580.

A concise review of sarcoma of the uterus and particularly of the cervix precedes the report of a case of sarcoma of the cervix in a fifty-nine year old patient. The patient's sarcoma was diagnosed from the biopsy of the posterior cervical lip and posterior vaginal wall. Radium treatment, 3,360 mg. hr., was given with 90 mg. of radium in the cervix and 50 mg. against the cervix. After eight months, re-examination showed no evidence of the sarcoma locally or systemically.

Despite great variations in reported results, radiation therapy is preferred for sarcoma of the cervix. Radiation therapy has two undisputed advantages over operation: the absence of operative mortality, and its applicability to the inoperable cases and certain residua.—*H. G. Moehring, M.D.*

Lott, Bruce D., and Alexander, Carter M. Basal cell carcinoma of the anus. *Ann. Surg.*, Dec., 1949, *130*, 1101–1103.

The early diagnosis of anal basal cell carcinoma presents considerable difficulty. A basal cell tumor of the anus does not readily lend itself to biopsy since the growth tends to grow away from rather than toward the surface of the anal mucosa. When this tumor is observed in its early stages it may easily be mistaken for any one of several common benign lesions such as a simple anal ulcer, a fibrosed varicosity, an aberrant lymph node, or even a small, circumscribed, low grade marginal abscess. Because of this the diagnosis of basal cell carcinoma of the anus may require repeated biopsies of the suspected lesion.

The authors report a case, with the hope that accumulated experience may lead to improved diagnosis and therapy. With the case described here only 9 cases of basal cell carcinoma of the anus have been reported.

In the authors' case the growth was locally excised and the wound bed generously fulgurated. Microscopic examination of the tissue removed revealed basal cell carcinoma. There were also areas of intra-epithelial carcinoma in the surface squamous epithelium near the mucocutaneous junction. The lesion was irradiated receiving a total of 5,500 r. When last seen, the affected area showed only a small soft scar.

With early diagnosis and local surgical excision of the lesion, with or without subsequent irradiation, the prognosis in basal cell cancer of the anus appears to be excellent. The prognosis in advanced lesions appears to be poor.—*K. K. Latteier, M.D.*

Lawrence, John H. The control of polycythemia by marrow inhibition. *J. A. M. A.*, Sept. 3, 1949, *141*, 13–18.

In 1938, after extensive animal and clinical studies, the author treated the first 2 cases of his series of polycythemia vera with radioactive phosphorus (P^{32}). Since that time 119 more cases of polycythemia vera have been similarly treated. Complete follow up records of 116 of these patients are available. Clinical and physiologic studies have been made on 172 patients suffering from polycythemia from various causes, Of these, 134 had polycythemia vera, 26 had mild polycythemia of unknown etiology and 12 had secondary polycythemia, associated with cardiac or pulmonary disease.

The patients with polycythemia vera had an average age of 50.7 years (19 to 75 years). Of these, 56.5 per cent were males and 43.5 per cent females. Palpably enlarged spleens were present in 65 per cent. Elevated white blood cells counts above 10,000 were noted in 68 per cent and of these 38 per cent had myelocytes or immature white blood cells.

During the period from 1939 through 1942, 30 patients were treated and this group has received one course on the average of every three years. One course has consisted usually of two injections of from 3 to 6 millicuries. In the group treated during the first five years, 28 per cent have had only one course of therapy,

some of them remaining under control for from four to eight years.

The causes of the 21 deaths in the group were: generalized arteriosclerosis (5), leukemia (5), neoplastic disease (3), coronary occlusion (3), cardiac failure (2), portal thrombosis (1), anemia and leukopenia (1) and cerebral thrombosis (1). Four of the 5 patients who died of leukemia showed evidence of a hyperactive marrow when first seen. The incidence of leukemia after P^{32} therapy showed no significant difference when compared to other forms of therapy. There was no evidence of the consistent occurrence of other complications which might be related to the treatment. It was shown by Hall that the incidence of thrombosis was reduced from 27 per cent to 2.4 per cent by P^{32} therapy. It is the opinion of the author that patients with polycythemia vera properly treated have as favorable an outlook as do patients with diabetes mellitus treated with insulin or those with pernicious anemia treated with liver.—*J. N. Ané, M.D.*

RADIOISOTOPES

DOBYNS, B. M., SKANSE, B., and MALOOF, F. A method for the preoperative estimation of function in thyroid tumors; its significance in diagnosis and treatment. *J. Clin. Endocrinol.*, Nov., 1949, *9*, 1171–1184.

The problem of learning, preoperatively, the degree of function of thyroid nodules has been approached by the authors with the construction of a special type of Geiger-Müller counter and checking results of this approach by radioautography. Reasons for certain errors are discussed. In the authors' summary it is stated that: "This method is of value in: (1) raising the suspicion of carcinoma, (2) the diagnosis of hyperfunctioning nodule with or without thyrotoxicosis, and (3) distinguishing between the diffuse hyperfunctioning gland of Graves' disease with an incidental nonfunctioning nodule, and a hyperfunctioning nodule with thyrotoxicosis." An extensive bibliography is included.—*John W. Karr, M.D.*

COPE, O., DOBYNS, B. M., HAMLIN, E., JR., and HOPKIRK, J. What thyroid nodules are to be feared? *J. Clin. Endocrinol.*, Oct., 1949, *9*, 1012–1022.

Using statistics from the Massachusettes General Hospital, Boston, the authors found 129 cases of carcinoma of the thyroid in the twelve years 1937 through 1948. Twelve of these malignant tumors were metastatic to the thyroid. In varying types of thyroid disorders, the incidences of malignancy were: less than 1 per cent in Graves' disease, 10 per cent in nodular goiter, and 19 per cent in goiters having single nodules or localized abnormalities. Since malignant tumors have less than normal functional capacity, the use of a scanning technique after a test dose of radioactive iodine proves helpful.—*John W. Karr, M.D.*

BLUMEL, JOHANNA. The action of radioactive phosphorus in Drosophila. *Science*, Feb. 24, 1950, *111*, 205–206.

Radioactive phosphorus was added to standard *Drosophila* culture medium in known concentration, and pairs of mature flies placed with it in vials. Twenty-five pairs of two types of flies, *D. virilis* and *D. melanogaster* were used. Results are tabulated for a period of twelve days after exposure. *D. virilis* proved much more susceptible than *D. melanogaster* to irradiation effects and the former took up much more of the isotope than the latter, according to the table. No mention of this fact is made in the author's discussion. Changes produced in *D. virilis* pertained mostly to eyes, legs, abdomen, wings and genitalia. Fertility was markedly reduced.

The author states "that P^{32} not only produces mutations in *Drosophila virilis* but also chromosomal arrangements."—*John W. Karr, M.D.*

BEIERWALTES, W. H., LAMPE, I., GOMBERG, H. J., and LOWERY, G. H. Radioiodine uptake curves in humans. III. The evaluation of radioiodine measurements made with counter tube in apposition to the thyroid isthmus. *Univ. Michigan Med. Bull.*, Jan., 1950, *16*, 2–6.

This paper shows experimental data from which it is concluded that skin contact counting as a technique for thyroid gland concentration of the isotope may give untrustworthy results due to geometric problems.—*John W. Karr, M.D.*

BEIERWALTES, W. H., GOMBERG, H. J., LAMPE, I., KNORPP, C. T., and BROWN, P. W. Radioiodine uptake curves in humans. IV. Comparative studies of short and long distance counting of thyroid radioactivity. *Univ. Michigan Med. Bull.*, Jan., 1950, *16*, 7–13.

This paper presents a body of data indicating the increased value of making the counts at

some distance from the thyroid. If a minimum distance of 25 cm. is used, then "the thyroid gland—may be treated as a point source of radiation." The authors also utilize a heavy lead tube leading from subject's neck to Geiger-Müller tube to exclude radiations from other sources than the thyroid.—*John W. Karr, M.D.*

Fitzgerald, Patrick J., Foote, Frank W., Jr., and Hill, R. F. Concentration of I^{131} in thyroid cancer, shown by radioautography. *Cancer*, Jan., 1950, *3*, 86–105.

This is a report of 100 consecutive specimens of carcinoma of the thyroid in 82 patients who have been given radioactive iodine. Radioautographs of the malignant tissue were made to study the function of these tumors so far as iodine concentration was concerned.

Radioautographs of normal thyroid gland show variability in the concentration of I^{131} from follicle to follicle. In 29 cases of papillary carcinoma, of the 11 predominantly papillary forms, none showed any uptake of radioiodine. In the mixed type, 8 out of 18 cases showed a concentration of radioiodine either in the primary or metastatic areas.

In 39 cases of alveolar and follicular carcinoma, 29 showed concentration of radioiodine. Of 21 cases with primary lesion, 15 showed an uptake while in 29 cases 23 showed an uptake (11 of the 29 cases had been primary and metastatic lesions). The concentration of radioiodine varied directly as the ratio of the colloid to the total aount of tumor tissue present.

In the mixed variety of solid type carcinoma, 4 cases were examined and they all showed positive radioautographs. In the spindle and giant cell type carcinoma, 6 cases were studied; none showed any iodine concentration. In 4 of these cases, normal thyroid concentrated the isotope but the carcinoma did not.

In summarizing the 100 cases, 46 concentrated enough of the radioiodine in the carcinoma to give a positive radioautograph. The presence of colloid is a factor in the uptake of the isotope. The ability of types of thyroid carcinoma to concentrate radioiodine is a reflection of the amount of colloid present in these types. The more the tumor resembles the normal thyroid follicle, the more likely it is to concentrate radioiodine. In therapeutic application, the authors conclude that the lack of homogeneous distribution of the isotope in normal thyroid and carcinoma tissue precludes real difficulty in calculation of dosage which is based on uniform distribution.—*James Durlacher.*

Nylin, Gustav, and Celander, Hjöordis. Determination of blood volume in the heart and lungs and the cardiac output through the injection of radiophosphorus. *Circulation*, Jan., 1950, *1*, 76–83.

A method, similar to the dye method of Hamilton, is outlined for estimation of the cardiac output. With the data obtained, the blood volume of the heart and lungs (referred to as the thoracic pool) was also determined. The authors refer to other publications for the details of the method. Red blood cells, labelled with P^{32} were used as the indicator. A given quantity of the labelled material is injected intravenously into the antecubital vein. Arterial blood samples are obtained serially at short intervals. If the concentration of P^{32} in the serial samples is plotted against time, a general dilution curve is obtained. The observed exponential character of the first portion of this curve (that portion of the curve which denotes primary circulation before recirculation occurs) has been correlated with an equivalent hydrodynamic system similar to that of Hamilton, Kinsman and Moore.

Cardiac output is estimated by graphical integration of the primary dilution curve. The distal portion of this curve is obtained by extrapolation. The calculation is based on establishing the mean concentration over a measured time interval. The cardiac output then is obtained dividing the mean concentration by this time.

The upper limit of the blood volume of the thoracic pool is obtained by multiplying the cardiac output by the time interval from the period of injection to the period of measurement of peak concentration. The lower limit of the thoracic pool is obtained by dividing the cardiac output by the exponential decrease of the initial slope. The average of these two gives the mean value of the thoracic pool volume.

Cardiac outputs, total blood volumes, and mean volumes of the heart and lungs were obtained on several patients. The thoracic volume was found to be 29 to 35 per cent of the total blood volume. Roentgenologic heart volumes of the patients were also determined. There appeared to be some correlation between the heart volume and the blood volume of the heart and lungs.—*Hymer L. Friedell, M.D.*

Gutmann, Helmut R., and Wood, John L. Detection of radioactive impurities by the constant solubility test. *Science*, Dec. 16, 1949, *110*, 662–663.

In work with radioactive compounds, it is of importance to establish that significant amounts of the radioactivity measured in the labeled material are not due to impurities. This is especially true in biological experiments in which the metabolism of a labeled compound is followed solely on the basis of radioactivity measurements. Radioactive contaminants in crystalline material often represent an amount of weight much smaller than can be detected by the common criteria of chemical purity. Outlined by the authors are specific procedures which take this problem into account.—*E. A. Addington, M.D.*

Knowlton, Norman P., Leifer, Edgar, Hogness, John R., Hempelmann, Louis, Blaney, Loren F., Gill, Dan C., Oakes, William R., and Shafer, Charles L. Beta ray burns of human skin. *J. A. M. A.*, Sept. 24, 1949, *141*, 239–246.

The authors present a carefully prepared and well illustrated summary of 4 cases in which beta-ray burns were sustained. These injuries were incurred as a result of deviation from prescribed procedures for handling radioactive substances. Estimates of doses indicate that the 4 men received 3,000 to 16,000 rep (roentgen equivalent physical) to the outer surface of the skin. These beta rays were calculated to have had an average maximum energy of about 1 mev (million electron volts). Depth effects were estimated at 300 to 1600 rep at 3 mm. and at 30 to 160 rep at 6 mm. Gamma radiation received concomitantly did not exceed 15 r to the whole body.

Large doses of beta radiation produce enough ionizing effect near the surface to be seriously destructive. Tingling and itching may be noticed at the time of the exposure soon followed by erythema and edema with or without blanching up to the end of the third day. After this initial reaction subsides, a latent asymptomatic period may last three to five days. A secondary erythema with vesicle formation next appears and passes on to desquamation after about three weeks, leaving new epithelium. Later, in the chronic phase, the skin becomes atrophic with loss of secondary epidermal structures. Telangiectases, hyperkeratoses and malignant degeneration are potential complications which may develop over a period of time.

Laboratory Findings. Positive findings in blood: (1) neutrophilia; (2) increased sedimentation rate; (3) increased refractive granules in the lymphocytes; (4) low grade reticulocytosis. Liver function, nitrogen balance, and urinalyses were consistantly normal.

Treatment was routine burn therapy with accessory chilling. Appropriate debridement and skin grafting were done later. Patients were given high protein diet, rutin, multiple vitamins and parenteral penicillin.—*John Turner, M.D.*

Selverstone, B., Sweet, W. H., and Robinson, C. V. The clinical use of radioactive phosphorus in the surgery of brain tumors. *Ann. Surg.*, Oct., 1949, *130*, 643–651.

Using radioactive phosphorus (P^{32}, half-life 14.3 days), the authors found a very definite difference in uptake of the element between tumor tissue in brain and normal brain tissue, the higher concentration being in neoplastic cells. Special Geiger-Müller counters were constructed in the form of probes of 2 mm. to 5 mm. diameter. These probes could be inserted into the brain in a similar fashion to ventricular needles. It was found that the probe must pass within 5 mm. of the tumor to give a significant change in count over the surrounding normal tissue. The patients were given a single intravenous injection of buffered radioactive phosphate ion (0.95 to 4.2 millicuries), preferably twenty-four hours before operation. After the brain was exposed, a control area at the periphery of the visible lobes was studied. The sensitive volume counter was pushed into the brain and counts recorded at various depths beneath the surface of the brain (first at 1 cm., and then at every centimeter until a depth of 4–6 cm. was reached). The counter was then used in suspicious areas and counts made until a tumor had been struck. After the tumor was found, successive approaches were made from the normal brain toward the tumor in an attempt to demarcate its boundaries.

Fifteen glioblastomas and 14 other cerebral tumors were successfully localized by this method. The ratio of corrected counts per minute for the tumor as compared to values for normal brain ranged from 73.4 to 5.4. In 13 instances an attempt at exact determination of the tumor's boundary was successful.

In 4 additional cases localization was not possible. One showed diffuse gliomatosis of an

entire cerebral hemisphere, therefore there was no accessible control area. Two solitary nodules in different patients were missed because of improper positioning of the counter. In another case no tumor was demonstrable and the patient's subsequent course has borne out the negative finding.

This method should be of great aid to the neurosurgeon in planning resection of brain tumors at time of operation.—*Harold Fulton, M.D.*

CHEMOTHERAPY

Landing, B. H., Goldin, A., Noe, H. A., Goldberg, B., and Shapiro, D. M. Systemic pathological effects of nitrogen mustards, and a comparison of toxicity, chemical structure, and cytotoxic effect, with reference to the chemotherapy of tumors. *Cancer*, Nov., 1949, *2*, 1055–1066.

These authors report the pathological results of thirty-four nitrogen mustards and six related non-mustard compounds on the blood and viscera of mice following intraperitoneal injection of between one and two median lethal doses (LD_{50}). Gross and microscopic changes are described and scaled as to degree of toxic damage in these tissues. The lymphoid system, bone marrow and testis were most susceptible to nitrogen mustard cytotoxic action. There was no significant effect on the hemoglobin, red cell, monocyte, eosinophil, or basophil counts. The white cell depletion tended to be correlated with the degree of damage found in the bone marrow and lymphoid tissues.

Twelve mustards and no nonmustards tested showed moderate to severe damage to two or more systems, with the same order of severity of effect to any one compound. Thus any of these adequately toxic mustards should have potential usefulness in treatment of malignant processes in man, and perhaps the one showing a larger tolerated cumulative effect in man might be theoretically the more desirable clinically. Bis or poly 2-chloroethyl compounds showed most severe lymphoid and bone damage. The study suggests also that very toxic compounds are less effective in producing visceral damage than those with slightly lower toxicity. Hence the choice of chemotherapeutic agent would seem to depend on the relative severity of side effects as compared with mustard effects.

The methyl-bis and ethyl amines now in common clinical use may not be the best mustards to give the desirable therapeutic ratio between the effect on the tumor and the undesirable effect on normal tissues. Data on which of the tested mustards will give this improvement are in preparation and apparently suggest that the poly-2-chloroethyl nitrogen mustards may prove superior in this regard.—*J. A. Campbell, M.D.*

Landing, B. H., Seed, J. C., and Banfield, W. G. The effects of a nitrogen mustard (tris (2-chloroethyl) amine) on regenerating rat liver. *Cancer*, Nov., 1949, *2*, 1067–1074.

The cytotoxic effect on the nitrogen mustards is known to be most marked in tissue with rapid rates of cell division. The liver has demonstrated a relative immunity to doses two times the median lethal dose and it has been postulated that this immunity might be due to the low rate of cell division in this organ.

The authors studied the effect of tris (2-chloroethyl) amine (HN_3) after partial hepatectomy, the latter procedure causing as rapid cell division as in other tissues more susceptible to the cytotoxic effect of tris. The method is described in detail and the results tabulated in several tables and graphs.

The results show that the process of mitosis is inhibited by tris (2-chloroethyl) amine but the apparent immunity of normal liver cells to this drug is not altered even in rapidly dividing cells after partial hepatectomy.—*J. S. Scott, M.D.*

Landing, B. H., Goldin, A., and Noe, H. A. Testicular lesions in mice following parenteral administration of nitrogen mustards. *Cancer*, Nov., 1949, *2*, 1075–1082.

This study consisted of the intraperitoneal injection in adult male mice of various forms of nitrogen mustards with normal saline and a diluent. Subsequently, at various intervals, the testes were subjected to microscopic examinations. These were compared to the findings in control groups.

The microscopic studies demonstrated mitotic arrests in the spermatogenic divisions, followed by pyknosis and degeneration. There was also evidence of direct cellular lysis. Abnormal metaphases and anaphases of the first two spermatogenic divisions were evident, and the abnormal cell growth was followed by lysis. Fusion of the secondary spermatocytes, and rarely the primary spermatocytes, formed bi- or multi-nucleated giant cells which eventually

underwent degeneration. The spermatogenic epithelium was disrupted and disorganized due to failure of new cells to develop and lysis and sloughing of damaged cells. These sloughed cells were passed down the tubules via the epididymis.

Studies of the testes at intervals within seventy-two hours again demonstrated the previous abnormal findings with progressions of each.

After the period of degeneration a recovery process was evident with an apparent loss of the abnormal cells and an increase in the normal cells. There was a gradual formation of mature sperm which exhibited normal motility and successful mating trials. The recovery of the spermatogenic function occurred by four weeks.

The cellular changes observed in this series has been described pathologically in several other processes other than the administration of nitrogen mustard preparations, namely, roentgen irradiation, vitamin deficiency and malnutrition, and exposure to other toxic chemicals. Consequently, it is concluded that the process is not specific for nitrogen mustards; but may be the result of disruption of the cellular metabolism due to the known enzyme-inhibitory action of the nitrogen mustards.—*J. W. Wilson, M.D.*

Landing, B. H., and Eisenberg, F. F. Nitrogen mustards; statistical analysis of effects on sarcoma 180 and viscera of normal mice in relation to toxicity and structure. *Cancer*, Nov., 1949, *2*, 1083–1086.

An effort was made to correlate toxicity, structure, tissue effects and effects on mouse sarcoma 180 of a number of nitrogen mustards. Toxicity factors and visceral tissue effects show fair correlation. However, no correlation could be drawn between the five methods used in studying the tumor effects of the mustards. In general the compounds with the greater number of 2-chloroethyl side chains produced more damage to sarcoma 180 and likewise to normal lymphoid tissue, bone marrow, gastrointestinal epithelium, circulating leukocytes and testes when given at the same fraction of lethal dose. It was thus thought that the effect of the mustards on the susceptible tissues of normal animals is a fair index of what effect can be expected on sarcoma 180. In no instance was a compound found to be more damaging to tumor cells than to normal susceptible ones.—*D. E. Vivian, M.D.*

Bauer, Richard D., and Erf, Lowell A. The clinical effect of nitrogen mustard on neoplastic diseases. *Am. J. M. Sc.*, Jan., 1950, *219*, 16–26.

A series of 210 patients suffering from a great variety of diseases were given one or more courses of four daily injections of nitrogen mustard.

A summation of the present day knowledge of the clinical properties and actions of nitrogen mustard is presented. The drug used was methyl bis (beta-chloroethyl) amine HCL or HN_2. The methods of administration and toxic effects are described. One hundred milligrams of pyridoxin hydrochloride intramuscularly thirty minutes after the administration of the nitrogen mustard was used to combat the nausea. The leukocyte count was used as criterion to proceed with or stop the series. Gastrointestinal hemorrhages were encountered in 6 cases and severe cerebral hemorrhage in 1 case.

Nitrogen mustard has been most widely used in Hodgkin's disease. It was found of particular benefit in roentgen resistant cases and when the disease is generalized. In some instances the patient became resistant to nitrogen mustard and in turn acquired roentgen sensitivity after having been roentgen resistant prior to the nitrogen mustard therapy. Hodgkin's disease of the bone was unaffected.

In 35 cases of carcinoma the results were very poor except in 2 cases of the adenomatous variety. However, in the 1 case that is described roentgen therapy was also instituted. In polycythemia vera nitrogen mustard had no value and intense vomiting produced severe cerebral hemorrhage in 1 case. Lymphosarcoma, follicular lymphoblastoma and mycosis fungoides responded to nitrogen mustard in a manner similar to that of Hodgkin's disease. The remissions grew shorter until the patient became insensitive to the drug. In leukemia and Kaposi sarcoma it was found that nitrogen mustard was contraindicated. In plasmacytoma of the fifth lumbar vertebra there was a complete relief of pain and in exfoliative dermatitis the eruption disappeared after two injections.

For each disease clinical results are summarized and in certain instances representative cases are described. The authors conclude that nitrogen mustard has not been found to cure any type of disease. Its value is only palliative. —*W. M. Maver, M.D.*

Shimkin, Michael B., and Bierman, Howard R. Experimental chemotherapy of neoplastic diseases. *Radiology*, Oct., 1949, *53*, 518–529.

Drawing from an extensive personal experience and a careful study of the literature, the authors present a comprehensive analysis of the present status of chemotherapy of neoplastic diseases.

Therapeutic agents and procedures can be placed in three general classes: (*a*) curative,—as evidenced by complete removal of the neoplastic process; (*b*) arresting agents,—which alter the course or nature of the neoplastic process; (*c*) palliative agents,—which influence neither the neoplasm or course of the disease, but alleviate the symptoms. Surgery and radiation remain the chief methods for cure, temporary arrest or palliation of neoplastic processes. Cancer research has failed to yield any chemical agents which are curative. Yet it is felt that effective agents can and will be found.

The literature abounds with enthusiastic preliminary reports of chemotherapeutic trials unsubstantiated by longer follow-up series. The authors have investigated seven specific agents or groups of agents, and classified them as to the general class of action, specific method of action, dosage and method of administration, untoward reactions and end results.

The specific methods of action of those agents thus far proved effective are: (*a*) attack of some physiologically normal function of the cancer cells; (*b*) alteration of the biochemical substrate of the tumor; (*c*) bone marrow and lymphoid tissue destruction or inhibition; (*d*) damage to the vascular supply to the tumor.

Potassium arsenite (Fowler's solution) is a useful adjunct in the treatment of chronic myelogenous leukemia. By bone marrow and lymphoid tissue destruction or inhibition temporary arresting effects are produced. Damage to the hematopoietic system is a danger.

Urethane has a place in the adjunctive treatment of chronic myelocytic leukemia and other leukemias. It is ineffective in Hodgkin's disease, lymphosarcoma or other neoplastic diseases. The effect is a temporary arresting one. Urethane is a bone marrow and lymphoid tissue depressant, and the untoward reactions of leukemia, thrombocytopenia, anemia and hemorrhagic tendencies can be expected.

The *amine mustards* (methyl-bis or tris (beta-chlorethyl) amine) find their best application in some lymphomas, particularly Hodgkin's disease, and occasionally in other neoplastic diseases. They can be expected to cause a remission of Hodgkin's disease in: (*a*) over 90 per cent of patients not previously treated with roentgen rays; (*b*) 70 per cent of patients previously treated with roentgen rays who are still responding favorably; (*c*) 50 per cent of patients who have had the disease three years or more and who are no longer responding to roentgen therapy. The life span is not prolonged, but effective and comfortable life is prolonged. General endogenous cell destruction accounts for the sharp negative balance in nitrogen, sodium and potassium encountered during active treatment. Bone marrow and lymphoid tissue destruction account for the severe depressive effects on platelets, red blood cells and the coagulation mechanism occasionally encountered.

Bacillus prodigiosus polysaccharide is a hazardous and seemingly unreliable agent which primarily affects the blood supply of tumors, occasionally decreasing the size of sarcomatous and lymphomatous tumors.

Stilbamidine is chiefly a palliative agent in multiple myeloma. Of 186 reported cases of multiple myeloma treated with the drug, 25 per cent had complete relief from pain, 38 per cent partial relief, and less than 5 per cent showed objective signs of improvement of bone lesions on radiographs. It is ineffective in other forms of neoplastic disease.

The *pteroylglutamic derivatives* ("teropterin") and ("diopterin") alone and in conjunction with amine mustard therapy have produced no objective effect on any neoplastic process. Occasionally a temporary sense of well-being has been observed. "Aminopterin" has produced apparent remissions in acute leukemias in children. The effects are not curative. Further investigation is indicated.

Castration remains the treatment of choice for disseminated prostatic carcinoma. Estrogenic therapy is indicated if the disease progresses despite orchiectomy. Estrogen therapy is also indicated in localized prostatic carcinoma before surgery, since reduction in size of the local lesion may make resection feasible.

The paradoxical action of both estrogens and androgens in mammary cancer may be explained by a sharp alteration in the hormonal substrate of the tumor, perhaps through intermediation of the hypophysis resulting in temporary regression until the neoplasm adjusts

itself to the new environment. The over-all length of survival is not influenced.

Roentgen therapy to localized bone or soft tissue metastases of carcinoma of the breast remains the treatment of choice. Androgen and estrogen therapy may be a valuable adjunct in the group of well differentiated tumors, and in cases where the extent of the disease precludes adequate roentgen dosage. Testosterone can be expected to produce subjective improvement in 50 per cent of patients with osseous metastases, while only 25 per cent show objective evidence of regression and recalcification. The estrogens are useful in older post-menopausal women with inoperable carcinoma of the breast with soft tissue metastases.—*G. J. Culver, M.D.*

BOYD, GEORGE A., and BOARD, FRANCIS A. A preliminary report on histochemography. *Science*, Dec. 2, 1949, *110*, 586–588.

This is a preliminary study on histochemography. Histochemography is defined as a gross picture on a photographic plate, or, at high magnification, a pattern of silver grains produced by chemical action of a histological specimen in direct contact with the emulsion of the plate.

The authors observed in 1948 that normal rat bone marrow diluted with clear dog serum blackened an Eastman NTB photographic plate when smeared directly on the emulsion surface and stored at approximately −15° C. for several days. It was noted that peripheral blood smears diluted with the same dog serum did not blacken the plate. This work emphasized the long suspected likelihood of histochemical fogging and possible misinterpretation of autoradiographs from unfixed tissue and the hazards of error in experimenters using autoradiographs.

The investigators felt the blackening had been produced by direct chemical action, the possibility of blackening by photons produced in the fresh tissue could not be overlooked. These possibilities of photon action are investigated by the authors. They do not infer that this type of artefact makes autoradiography impossible. Those interested should read the article in its entirety.—*E. A. Addington, M.D.*

TSEVRENIS, H., THUILLIEZ, A.-C., and FOUSSIER, B. Sur dix-uit cas d'hémopathies malignes traitées par la moutarde à l'azote. (On 18 cases of malignant hemopathy treated with nitrogen mustard.) *Presse méd.*, Jan. 14, 1950, *58*, 18–20.

Eighteen cases treated intravenously with nitrogen mustard at Hôpital Corbeil in Paris are discussed and the results are described as follows: Treatment is generally well accepted by the patient and easily administered, on condition, however, that the blood count be closely watched and checked. The treatment is not indicated in diseases actually hematopoietic such as chronic leukemia, acute leukemia or the *late* stages of Hodgkin's disease. On the contrary, it is indicated in the *initial* stage of the latter disease and in sarcoma localized or generalized.

The combined action of radiotherapy and nitrogen mustard therapy proves far more efficient than the separate action of each. By combining the methods the authors have caused radioresistant tumors to become radiosensitive. This therapeutic association seems to be synergistic and to act more strongly and for a longer time. Small repeated and spaced doses of nitrogen mustard gave more effective and prolonged results than high doses. The spectacular remissions obtained by the large doses are of short duration, while the results produced by small and fractionated doses, although less spectacular, have a more durable action.

The technique of administration of the particular nitrogen mustard used (methyl bis) is described.—*William M. Loehr, M.D.*

SULLIVAN, MAURICE. Treatment of cutaneous carcinoma with podophyllin. *Bull. Johns Hopkins Hosp.*, Sept., 1949, *85*, 200–203.

Podophyllin has cancerocidal potentialities but at the same time changes produced in adult normal cells are reversible within certain limits. The topical application of podophyllin for prolonged periods is safe provided contact with the eyes is avoided. The response of cutaneous carcinoma to the topical application of podophyllin is impressive. Of 20 various sized lesions followed in 15 patients after destruction by multiple applications of 25 per cent suspension of podophyllin in mineral oil or a 20 per cent solution in alcohol only one 12 by 14 cm. basal cell carcinoma failed to respond satisfactorily. The lesions were basal cell carcinomas, intra-epidermal carcinomas, and a prickle cell carcinoma as proved by biopsy in the 15 patients. The average healing time was forty-

nine days after the first topical application. The treated area healed with a pliant slightly atrophic scar which resembles a successful roentgen irradiation scar. Follow-up periods average approximately six months. So far the results are encouraging but more detailed descriptions will be published later after sufficient data is accumulated for proper evaluation of the method.—*J. J. Wiesner, M.D.*

Bickel, Georges. La chimiothérapie des tumeurs malignes. (Chemotherapy of malignant tumors.) *Radiol. clin.*, Sept., 1949, *18*, 345–348.

This is the résumé of a report. The agents used in chemotherapy of malignant tumors may be divided into four categories:

(1) Biochemical drugs. This group includes the toxins and the Bogomoletz serum.

The most important anticancerous toxins are the polysaccharides which have a remarkable effect when injected in animals but are little used in the human. The Russians claim rather great success from a toxin isolated from the cultures of *Schizotrepanum cruzi*, known under the intials of K. R. (from the names of Kliueva and Roskin) but confirmative experience is lacking.

The Bogomoletz serum, or cytotoxic antireticular serum, is likewise used on a large scale in Russia. Its function is to stimulate the defense mechanism of the reticulo-endothelial system. It is prepared by inoculating the horse with fragments of spleen and bone marrow toxin from human cadavers. The serum has a marked cancerolytic property in mice. Its use for the treatment of human cancer, however, did not give in the hands of the American clinicians who employed it the good results indicated in U. R. S. S.

(2) Radioactive isotopes. The report makes mention of the radiophosphorus used chiefly in polycythemia vera and less frequently in the chronic leukemias and of the radioiodine the use of which is justifiable only in the small group of functional cancer of the thyroid.

(3) Radiomimetic chemical agents. The name radiomimetic is used to express the fact that the chemical agents included in this group produce on the cancer cells an effect which is broadly analogous to that seen following roentgen irradiation. The most efficacious among them are the urethane, the nitrogen mustards, the aromatic diamidines and the antagonists of the folic acid.

The experience with urethane and nitrogen mustards, as indicated in this report, is similar to that already known. Of the aromatic diamidines, stilbamidine and pentamidine are useful in multiple myeloma for the relief of pain.

The folic acid antagonists differ from all other radiomimetic agents in that they have a beneficial influence not only on the chronic and subacute forms of the leukemias but on the acute forms as well. The most widely used among them is the aminopterin which produces an amelioration in about one-third of the acute leukemias lasting exceptionally as long as one year. More recent representatives of the folic acid antagonists (amethopterin, amino-an-fol) are under study.

(4) Hormones. The only hormones which have an undeniably beneficial action are the sex hormones and some of their synthetic derivatives. The value of the estrogens in prostatic cancer and in adenocarcinoma of the breast in women over sixty years of age and of the androgens, especially of the testosterone derivatives, in carcinoma of the female breast is discussed.

The general conclusion is reached that chemotherapy in all forms has a limited palliative usefulness. The time has not yet arrived when it can replace either surgery in the operable cases or radiation therapy in the radiosensitive cases of malignant neoplasms.—*T. Leucutia, M.D.*

MISCELLANEOUS

Van Winkle, Walton, Jr. The action of steroid hormones in mammary cancer. *Radiology*, Oct., 1949, *53*, 530–539.

This paper is a preliminary report of a study being carried out under the direction of the Therapeutic Trials Committee of the Council on Pharmacy and Chemistry of the American Medical Association. Fifty clinics are cooperating, using various dosages of testosterone and estrogens, including five types of the latter.

Subjective improvement is defined as marked relief from pain, usually evidenced by discontinuance or significant reduction in narcotics, marked increase in activity, particularly ambulation, or subsidence of complaints referable to the disease, or combination of these.

Objective improvement is considered to have occurred when serial roentgenograms showed recalcification of bony lesions or when soft tissue lesions disappeared or regressed significantly.

Initial reports were submitted to the Committee on 270 cases, but only 94 cases treated with testosterone and 21 treated with estrogen are reported in detail in this paper.

Of 77 cases of breast cancer with bone metastases which have received up to one year's treatment, 45 per cent have shown a favorable response to testosterone therapy, although only 13 per cent have shown objective improvement.

The results of testosterone treatment in 17 cases of breast cancer with only soft tissue lesions show a similar incidence of objective improvement, but the degree of subjective responses is significantly lower than in the cases with bone metastases. This is probably due to the fact that pain is such a common finding in the patient with bone involvement.

Of 21 patients with breast cancer receiving estrogen therapy, 5 showed objective improvement.

The writer emphasizes that none of the results to date indicate that hormone therapy should replace surgery or radiation therapy whenever these forms of treatment are indicated or feasible and that it may be tried when all other forms of treatment have been given a full and adequate trial and have failed.—*G. J. Culver, M.D.*

TULLIS, JOHN L. Radioresistant cells in certain radiosensitive tissues of swine exposed to atomic bomb radiation. *Arch. Path.*, Aug., 1949, *48*, 171–177.

This is a report of a member of the Naval Medical Research Institute at Bethesda, dealing with the studies carried out on the Bikini swine used in the atomic bomb tests in 1946. The tissues showing the most marked effects were the lymphoid organs, including lymph nodes, spleen, thymus, tonsils, and circulating lymphocytes. The bone marrow, intestinal epithelium and gonads also were found to be markedly radiosensitive. The author called attention to the interesting observation that the so-called "stem cells" which are found in the lymphoid organs, bone marrow, the indifferent cells of the testes, and the primordial ova are comparatively radioresistant. This represents another exception to the law of Bergonié and Tribondeau. The reason for the relative radioresistance of such stem cells is not clear.—*C. L. Hinkel, M.D.*

SCOTT, WILLIAM H., and CANTRELL, JAMES R. Colonmetrographic studies of the effects of section of the parasympathetic nerves of the colon. *Bull. Johns Hopkins Hosp.*, Oct., 1949, *85*, 310–319.

The effects of section of various nerves supplying the colon upon the tone, sensitivity and size of the colon in dogs was studied. This was done by means of colonmetrographic and roentgenographic apparatus. Control colonmetrograms were gotten in anesthetized dogs by connecting the colon to a manometer by means of a Foley catheter. To this system a jar of dilute barium sulfate solution was connected and the colon filled under fluoroscopic control. The colonmetrogram was then completed by plotting the volume of fluid introduced against the manometer pressure readings in graphic form. In 6 dogs the vagus nerve trunks were divided above the diaphragm. Subsequent colonmetrogram and roentgenographic studies showed no appreciable change from the controls run before section. In 7 dogs bilateral section of pelvic nerve trunks (nervi erigentes) was performed. Subsequent colonmetrograms showed consistent reduction in tone and reactivity to stretch stimuli while roentgenograms showed slight dilatation of the distal half of the colon in most animals. In 4 dogs section of the hypogastric (sympathetic) trunks brought about no appreciable change in the colonmetrograms or roentgenograms of the colon.

Colonmetrograms and barium enemas were also performed before and after vagotomy in patients who were treated for peptic ulcers. No appreciable differences were found in comparing the preoperative and postoperative studies.—*J. J. Wiesner, M.D.*

HUNTER, S. W., MIREE, JAMES, and BLOCH, HENRY. Compounds of zirconium for x-ray media. *Surgery*, Oct., 1949, *26*, 682–684.

The authors have presented some experimental data concerning compounds of zirconium that were employed as radiopaque media.

Sodium zirconyl citrate was used in an attempt to concentrate anions of zirconium within the substance of brain tumors in order to render these neoplasms opaque to roentgen rays. In the presence of a brain tumor the protective mechanism of the blood-brain barrier is altered. As a result of this change ions carrying a negative charge may accumulate in the involved tissues. Thus far this result has not been accomplished. A solution of zirconyl citrate injected into a vein of a rabbit was rapidly excreted by the kidneys, and a roent-

genogram made at this time showed a good image of the parenchyma of these organs. Impurities in the compound now employed prevent clinical evaluation at this time.

A comparison of the roentgenographic densities of solutions that contain equal percentages and equal molecular concentrations of lead, barium, and iodine with those of zirconium indicates that the solutions of zirconium are more opaque to the roentgen rays than those of barium or iodine and that they approach the opacity of the solutions of lead. The exact toxicity of the pure zirconium compound has not been established.

It is suggested that solutions of zirconium might be used to advantage as radiopaque media for the study of partially obstructing lesions of the bowel and for use in cases in which intestinal fistulae are suspected. Other compounds of zirconium are now being studied by the authors.—*C. B. Holman, M.D.*

Crouse, Helen V. The resistance of Sciara (Diptera) to the mutagenic effects of irradiation. *Biol. Bull.*, Dec., 1949, *97*, 311–314.

On the basis of irradiation studies made on *Sciara* to date with reference to the mode of action of roentgen rays on the hereditary material, there seems to be a resistance to the mutagenic effects of irradiation with visible mutations appearing at a negligible frequency.

From experimental evidence the author presents new data which support the view that the visible mutation rate induced in this genus is lower than that found in *Drosophilia* and a higher dominant lethal mutation rate is revealed.

Several factors which may account for the low visible mutation rate in *Sciara* are: (1) The external appearance of this fly is such that only the most conspicuous visible changes are likely to be detected. (2) There is a distinct difference between the autosomal and the sex-linked mutations which suggest that the induced mutation rate in this genus is considerably greater than the detected mutation rate. (3) The presence in germ cells of *Sciara* of large amounts of heterochromatin in the form of the limited chromosomes may actually retard the mutation rate. (4) It is conceivable that as compared to *Drosophila* the biochemical pathways which are available in *Sciara* result in a more restricted range of phenotypic variability.

The article includes more detailed comparison with other experimental work of this type and the actual chromosomal changes and means of breeding following irradiation used.—*J. H. Gilmore, M.D.*

Cohen, Lionel. Clinical radiation dosage. II. Interrelation of time, area and therapeutic ratio. *Brit. J. Radiol.*, Dec., 1949, *22*, 706–713.

The author has previously published evidence that tumor lethal doses and tissue tolerances could be specified and could be expressed as various combinations of radiation quality, time, and field size. An equation has been worked out expressing these factors; and for epidermoid cancer the recovery exponent and diffusion exponent, two factors previously estimated, have been accurately determined from published data from various sources.

Using these data a nomogram has been constructed relating the field size, time of treatment, dose in gamma or x-ray roentgens, and the clinical result to be expected. From another nomogram can be obtained the optimum overall time and if the treatment proposed is unsuitable, this is also indicated.—*E. F. Lang, M.D.*

Fry, D. W. The synchrotron accelerator—its potentialities as a generator of x-rays and electrons of 10–50 MeV energies for medical use. *Brit. J. Radiol.*, Aug., 1949, *22*, 462–472.

The basic principles of the beta synchrotron are explained and compared with other machines for accelerating particles in a circular orbit, the cyclotron and the betatron. The electrons in a synchrotron are accelerated by radiofrequency power applied tangenital to the circular orbit. The orbit is maintained by a magnetic field at right angles to the plane of the orbit and this field must increase at the same rate as the particle energy. A large iron core is not necessary, as in the betatron, eliminating a certain amount of weight and size.

A somewhat technical description of the characteristics and circuit of the synchrotron is given. In Great Britain a machine operating at 30 mev. has an output of 15 roentgens per minute at 1 meter.

The characteristics of the radiation from synchrotrons are similar to those of betatrons. A graph of the angular distribution of radiation intensity is presented. Little work has been done as yet on the energy spectrum. The mean intensity and output pulse shape of roentgen rays are discussed. The possibility of using the

synchrotron as a source of electrons is discussed although this will be more difficult than in the case of a betatron.

At present the efficiency of these machines is rather low, but by improvement of the process of injecting electrons, the efficiency will be improved.—*E. F. Lang, M.D.*

Salgueiro, Lidia, and Valadares, Manuel. Les spectres L et gamma émis dans la transmutation RaD→RaE. (L and gamma spectra emitted in the transmutation of RaD→RaE.) *Portugaliae physica*, 1949, *3*, 21–27.

For a long time the gamma spectrum emitted in the transmutation of RaD→RaE was regarded as monochromatic. In 1939, Amaldi and Rasetti, using the method of selective absorption, were the first to show that the radiation is complex. Following this, the study of the spectrum $\gamma+X$ emitted by RaD constituted the object of extensive research by various methods such as selective absorption, crystal diffraction, analysis of the beta-ray spectrum, Wilson cloud chamber studies and very recently by utilizing a proportional counter.

In the present article the authors (1) review the study of the L spectrum to determine to what extent the hypothesis of the internal transitions $L_I \rightarrow L_{II}, L_{III}$ can account for certain anomalies of intensity priorly indicated, and (2) study for the first time by the method of crystal spectrography the spectral region of wavelengths above the L spectrum.

The spectrographic installation is described in detail and the results obtained are discussed at length.

(1) The L spectrum of the roentgen rays of an element of atomic number 83 (transmutation RaD→RaE) extends from 755 to 1314 x-units. To avoid the K discontinuity, due to the bromine absorption inherent in the photographic method, which is placed at 918 x-units the authors confined themselves to the range above 918 x-units. In this range four bands were observed corresponding to wavelengths of 935, 956, 983, and 1146 x-units. Although these values closely approximate the wavelength values of Frilley and Tsien established by the method of crystal diffraction, there are some discrepancies in the corresponding intensities. These discrepancies are analyzed one by one and coordinated with the findings of Frilley and Tsien and other investigators.

(2) In the region between 1200 and 1800 x-units five bands were observed corresponding to wavelengths of 1315, 1400, 1550, 1690 and 1755 x-units. Although all of these rays are very weak (the strongest being those of 1400 and 1690 x-units), their existence cannot be doubted since they were shown on at least three spectrograms. With the exception of band 1315 which may correspond to the "*l*" line of L spectrum and band 1690 which corresponds to the 7.3 kev. energy level discovered by Tsien and Marty all other bands were identified for the first time.—*T. Leucutia, M.D.*

Broderson, H. Ein endobronchialer Radiumträger. (An endobronchial radium applicator.) *Strahlentherapie*, Dec., 1949, *80*, 573–576.

An endobronchial radium applicator is described which permits air to pass to the bronchi beyond it and which possesses flexibility to permit the bronchial lumen to dilate and contract at the site of application.—*H. G. Moehring, M.D.*

Meyer, Ralph R. A method for measuring children's hearts. *Radiology*, Sept., 1949, *53*, 363–370.

Since the formula for predicting the normal frontal plane area of the heart in children is different from that in the adult, the author presents a nomogram for use in children between the ages of three to sixteen years, inclusive. The chest film must be made in the upright position, at a distance of 72 inches, with the anterior surface of the chest closest to the film. The long and short diameters are measured in exactly the same way as for adults. The nomogram provides scales for obtaining the net frontal plane area from these diameters, as well as the predicted frontal area from the height and weight values. A line connecting the net frontal and predicted frontal plane areas, intersects a scale from which the percentage variation from normal can be read directly.

If the stature is greater than 170 cm., the adult nomogram must be employed. The heart is considered suitable for measurement only if the cardiac apex is visible and the position of the right diaphragm is normal in relation to the left.—*C. N. Borman, M.D.*

Scott, Wendell G., and Moore, Sherwood. Rapid automatic serialization of x-ray exposures by the rapidograph, utilizing roll film nine and one-half inches wide. *Radiology*, Dec., 1949, *53*, 846–858.

A résumé of the development of roentgeno-

graphic equipment for rapid exposure of films is presented in detail. The authors describe the mechanical and construction problems which presented themselves during the development of the new rapid exposure device which they term the "rapidograph." Angiocardiograms and cerebral angiograms are used to demonstrate the effectiveness of this machine. It is proposed to have two rapidographs at right angles to each other so that anteroposterior and lateral views of the heart and skull can be made simultaneously after one injection of an opaque medium. The outstanding feature of the rapidograph is the use of 9½ inch wide roll film with a self-cocking Potter-Bucky grid. A large number of exposures may be made in a short time and with a minimum of noise and vibration.—*C. A. Stevenson, M.D.*

Schack, Jerome A., and MacDuffee, Robert C. Increased radioresistance of red bone marrow after anoxia. *Science*, Sept. 9, 1949, *110*, 259–260.

It has been previously observed that red bone marrow of rabbits, in which a regenerative anemia has been produced by phenylhydrazine hemolysis or by repeated bleeding, shows less histological injury following 800 r of total body roentgen irradiation than does the normal. This study is a confirmation of the above observation, the only difference is that mice were used in the experiment and regenerative anemia was produced by partial anoxemia.—*E. A. Addington, M.D.*

Spiers, F. W. The influence of energy absorption and electron range on dosage in irradiated bone. *Brit. J. Radiol.*, Sept., 1949, *22*, 521–533.

Evidence from calculations and experiments has been analyzed to determine the physical radiation dose received by soft tissue enclosed in bone. If bone tumors are to be irradiated therapeutically, and this treatment is to be followed by repair in the supposedly healthy adjacent irradiated bone, the tolerance dose of the capillaries in haversian canals, and of osteocytes in even smaller cavities, becomes a limiting factor in the radiation dose.

The results of this investigation are somewhat tentative but there is evidence indicating that the tolerance dose of bone is about one-half that of soft tissues in the 200–250 kv. range. For softer radiations used in medium or superficial therapy the tolerance may be one-third that of soft tissues. In the range of 1 mev. or in gamma radiation, the tolerance of bone is probably about the same as soft tissues.—*E. F. Lang, M.D.*

Duryee, William R. The nature of radiation injury to amphibian cell nuclei. *J. Nat. Cancer Inst.*, Dec., 1949, *10*, 735–795.

The author studied in extenso the physiological mechanism by which the nuclei of amphibian eggs are damaged by graded doses of roentgen rays.

As is known, there are two effects of the ionizing radiations which are assumed to be responsible for the injury of nuclei: the direct effect on the components of the nucleus (target theory or direct hit theory) and the indirect effect from the side of the cytoplasm (theory of indirect effect by ionization of water, Barron theory of indirect action by formation of stable organic peroxides, etc.). The author's earlier results on frog eggs have been used in the literature for the support of the contention that the cytoplasm is mainly affected.

In the present article an extension of the former work is presented. The experiments are listed under three headings: (1) those deriving from the whole body irradiation of a series of 80 salamanders with graded doses of 1,000 to 10,000 r, the experiments also including a study of the role of low post-irradiation temperatures in delaying nuclear injury; (2) those concerned with the effects on isolated ovaries, on single cells, on isolated nuclei and chromosomes, and on fresh concentrated cytoplasmic brei of several subsequent series of *Anurans* and the Japanese salamander irradiated with graded doses up to 70,000 r; and (3) those resulting from the microinjections of normal ovarian eggs with irradiated (3,000 r) and normal cytoplasmic material, the donor and host salamander throughout the series being *Triturus viridescens*.

The roentgen irradiation was carried out at the Marine Biological Laboratory with 182–194 kv., no filter and at the National Cancer Institute with 186 kv., no filter. The target distance was 35 cm. for whole animals, 9.5 and 12.7 cm. in the case of eggs and nuclei. Intensities ranged from 450 to 6,100 r/min. for whole animals and from 6,100 to 7,600 r/min. on the isolated cells. Total doses varied in graded steps from 500 r to 100,000 r in a few cases. The great majority of experiments was performed at the 300 r level with whole animals

and at the 30,000 to 60,000 r level with individual eggs.

The author describes the positioning of the irradiated material and the technique of microinjection of the cytoplasmic material. He then analyzes in considerable detail the results of the experiments listed under the three headings.

In summary, the author offers a cytochemical hypothesis of radiation injury which presumes the following three phenomena: "(1) Production of localized radiochemical events (involving damage to sensitive molecules, such as enzymes, and possible formations of peroxides). These are apparently temperature insensitive since they are instantaneous occurrences at the molecular level. (2) Accumulation of toxic katabolic substances rather more than production of new toxic substances of intermediate metabolism. Because these involve chain reactions that might be interrupted or delayed unevenly, products at successive substrate levels would be variable both as to time and quantity. It would be expected that these secondary events are highly temperature sensitive. (3) Transmission of toxic products or accumulations in various parts of the cell including the nucleus. Observable nuclear reactions have been found to depend on diffusion and should be more affected by local viscosity changes than by temperature."

Eighteen beautiful plates are included illustrating various stages of injury of the cells and isolated cell parts due to irradiation.—*T. Leucutia, M.D.*

Hempelmann, L. H. Potential dangers in the uncontrolled use of shoe-fitting fluoroscopes. *New England J. Med.*, Sept. 1, 1949, *241*, 335–336.

Injuries liable to result from uncontrolled use of shoe-fitting fluoroscopes include interference with normal foot development of children who are fluoroscoped repeatedly when being fitted with new shoes; acute radiation burns of the customer's feet, resulting in later permanent skin damage; chronic radiation injury of the blood-forming tissues of store employees. Clinical and experimental evidence suggests that a few hundred roentgens administered in a single exposure might easily cause a disturbance in foot development in young children. Serious radiation burns of the skin probably require 600 to 1,000 r delivered by a fluoroscopic shoe-fitter. The hazards to the blood-forming tissues are similar to those in a professional roentgen laboratory. Maximum permissible daily radiation dose has been considered for many years to be 100 milliroentgens, but within recent months the Advisory Committee on X-ray and Radium has recommended that the permissible dose be lowered to 300 milliroentgens per week. Clerks working in the vicinity of shoe-fitting fluoroscopes can easily receive considerably more than the maximum permissible dose.

The author recommends better shielding, reduction in tube output, adequate filtration, and education of personnel as to the dangers of misuse to themselves and to their customers. The recommended limit of the Massachusetts Department of Hygiene, 1 r per viewing, three exposures per day, and twelve exposures per year, seems preferable to the higher doses permitted by other supervising and recommending agencies.—*H. P. Brean, M.D.*

Williams, Charles R. Radiation exposures from the use of shoe-fitting fluoroscopes. *New England J. Med.*, Sept. 1, 1949, *241*, 333–335.

The usual shoe-fitting fluoroscope, now in common use in shoe stores, consists of a 50 kv. roentgen tube operating at 3 to 8 milliamperes through a 1 mm. aluminum filter, the target-skin distance varying from 7.5 to 20 cm. Usual exposure time approximates twenty seconds, but variation from five to forty-five seconds was noted. Measurements on twelve separate units showed dosage rates varying from 0.5 to 5.8 r per second. For the commonly used twenty-second exposure, dosages of from 10 to 116 r are delivered to the customer's feet. Repeated fittings multiply the exposure proportionately.

Scattered radiation through the foot opening in the unit in most installations amounts to more than 100 milliroentgens per hour at 10 feet, 15 milliroentgens per hour at 25 feet. A clerk working in the exposed area could easily receive a daily dose larger than the 100 milliroentgens suggested as permissible by the American Standards Association. In addition, direct leakage through the cabinet wall ranges from 3 to 60 milliroentgens per hour.—*H. P. Brean, M.D.*